
L E T T E R S,
PHILOSOPHICAL and ASTRONOMICAL,

In which the following Operations of Nature are treated of and explained, in the most simple and natural Manner,

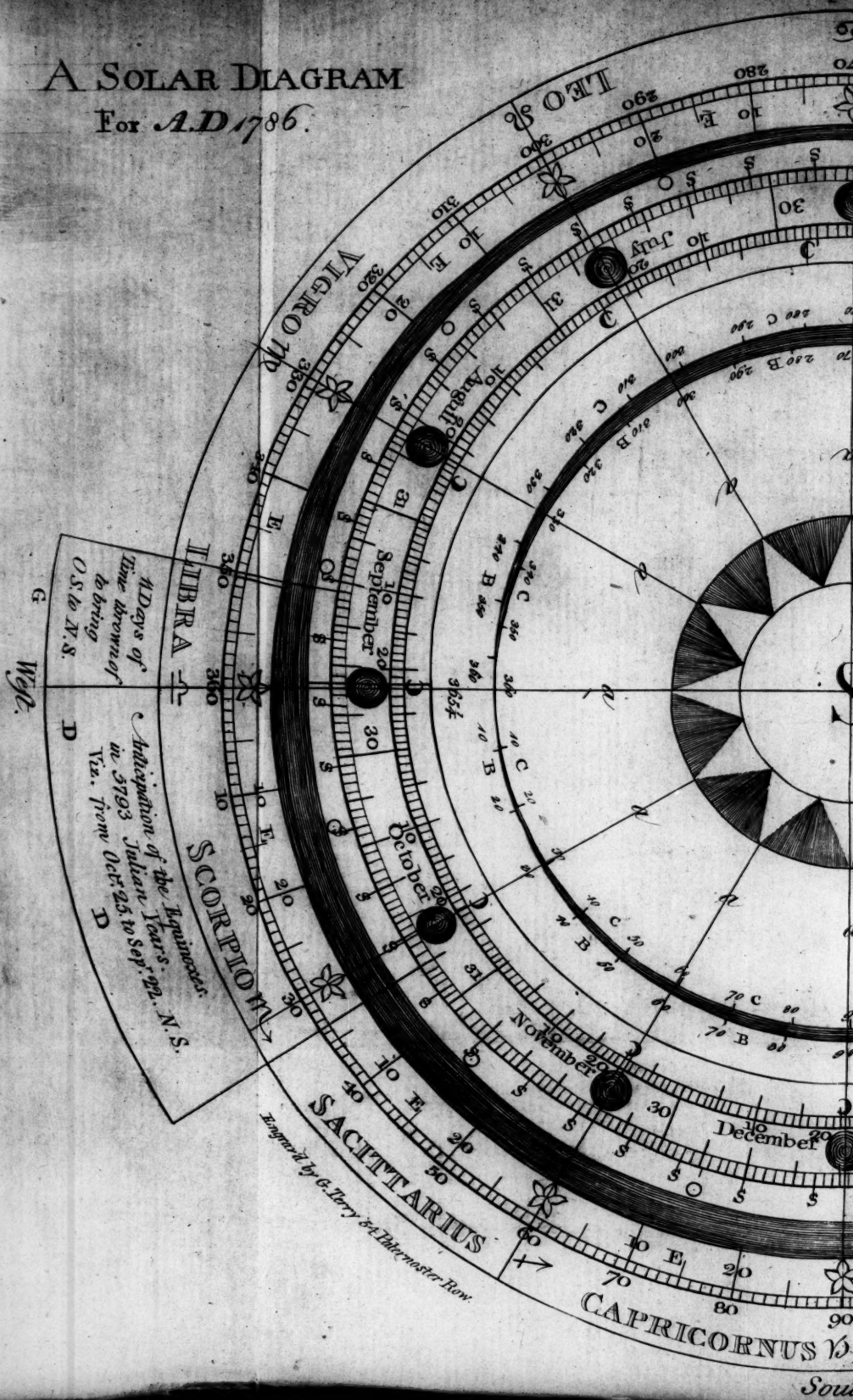
According to Sir ISAAC NEWTON's Opinions,

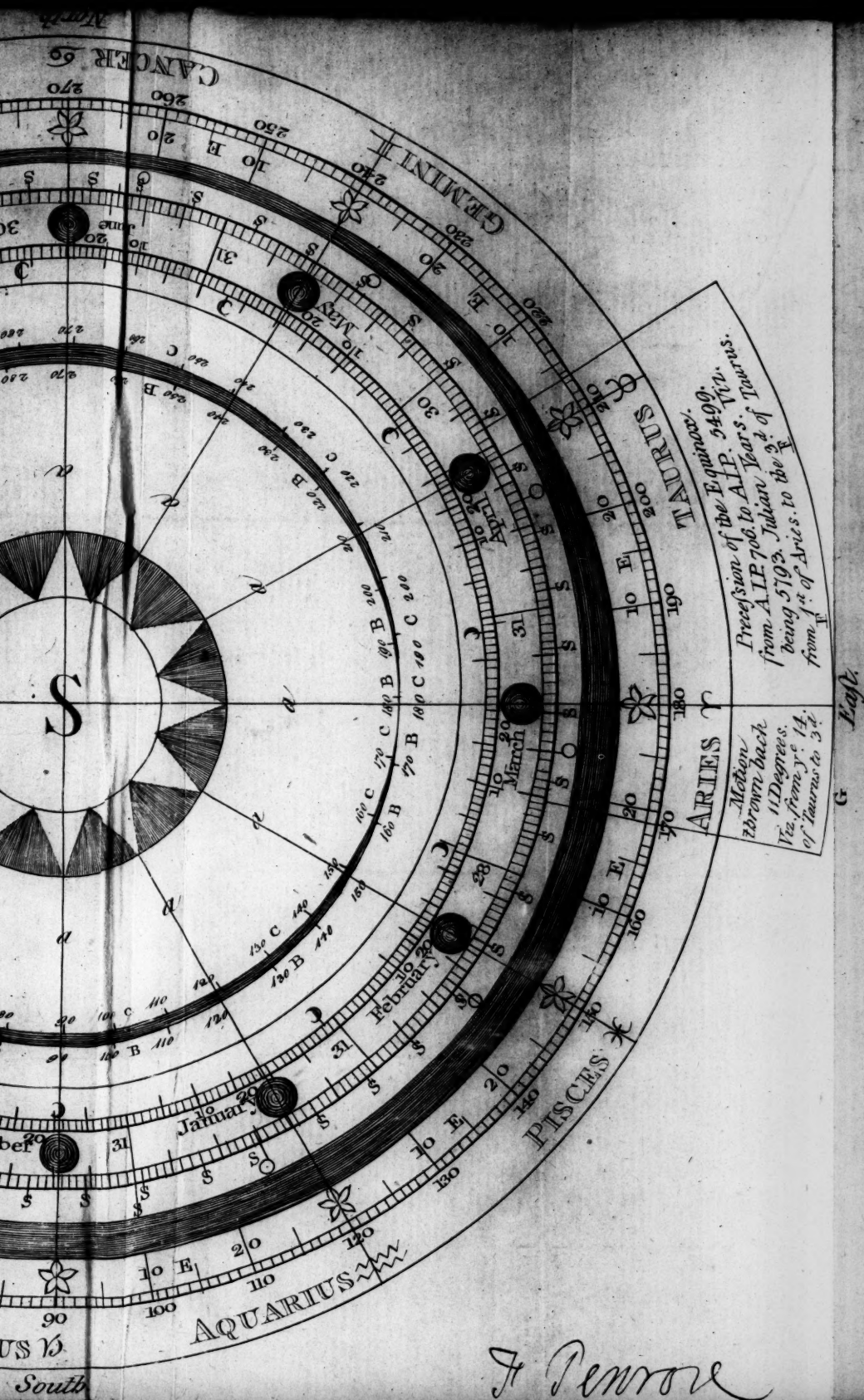
(V I Z.)

The Creation; the Deluge; Vegetation; the Make and Form of this terraqueous Globe;—its Motions explained and accounted for, &c.

PRICE SIX SHILLINGS,

For *A.D.* 1786.





102c

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According to Sir ISAAC NEWTON's Opinions,

(V I Z.)

The Creation; the Deluge; Vegetation; the Make and Form of this terraqueous Globe;—its Motions explained and accounted for.

TOGETHER WITH

The exact Number of Days, Years, and Lunations, since the Creation.

Proved by the New, Full Moons, Equinoxes, and Eclipses.

To which is added,

A solar and a lunar Diagram for A. D. 1786,

In which the Place of the Sun, Earth, Moon and her Nodes, are pointed out every Day in the Year, and every Day of the Week.

“ There are AGENTS in Nature able to make the Particles of Bodies stick together by very strong Attractions, and it is the Business of Experimental Philosophy to find them out.” Newton's Opt. P. 369

“ We see that Nature exerts a considerable but secret Power in carrying on her Productions, which demonstrates the Wisdom of the Author of Nature, in giving such due Proportions and Directions to these Powers, that they uniformly concur to the Productions of natural Beings ” Hale's Statical Essays, Vol. 1. P. 346.

“ And that the all-wise Creator has observed the most exact Proportions of Number, Weight, and Measure, in the Make of all Things.—The most likely Way, therefore, to get any Insight into the Nature of those Parts of the Creation, which come within our Observation, must, in all Reason be, to Number, Weigh, and Measure. —Hale's Introduct. P. 1.

P L Y M O U T H:

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M,DCC,LXXXIX.

K. Penrose (F.)

12



To Sir Joseph Banks, President,

AND TO THE

*Fellows of the Royal Society,
London,*

S I R S,

THE following Letters contain many new Observations in Astronomy and Philosophy, which appear to be of sufficient Importance to be inquired into, in Order to ascertain whether they be Facts or not.—On that Persuasion, I have taken the Liberty to address them to you, and hope they will meet with an impartial Examination; and that they will not be discarded because they contain some Things which differ from Opinions generally received and taught.—Was this *always* to be the Case, there would be

DEDICATION.

be an End to Improvements in the Sciences; for every Thing *new must differ* from what was before known.

It would have given me great Satisfaction, could I have obtained the Honour for some of the most important Matters in them, to be read at a Meeting of your Society; I should then have been properly informed whether they were of sufficient Importance to trouble the Publick with or not; but, as I had not Intérest enough to get that done, I take this Method to crave your liberal Decision on them,

I am,

With great Deference and Respect,

Your most obedient, humble Servant,

F. PENROSE,

STONEHOUSE,
Plymouth, June 30, 1788.

An Explanation of the SOLAR DIAGRAM,
for the Year of our Lord, 1786, (an-
swering to the Year of the World, 5793,
and to the Year of the Julian Period, 6499)
shewing the Place of the Sun, Moon, and
Earth, every Day in the Year, according
to the Julian Calendar.

S.—*The Sun in the Centre of the System.—*
a, a—Meridians, going from the Equator,
through the Ecliptick, to the twelve Signs, or
fixed Stars in the Equinoctial; shewing the
Day of the Julian Month, when the Sun comes
into these Meridians, or enters these twelve
Signs.

B. B.—*The Equatorial Circle divided into*
360 Degrees.—*If the Plane of the Equator be*
produced to the Heavens, it will there mark out
a Circle, called the Equinoctial, marked E. E.
which will divide the Earth and Heavens into
two Halves or Hemispheres.

C. C.—*The Ecliptick, an Ellipse, which*
is found to be inclined to the Equinoctial, at an
Angle of $23^{\circ} 28'$, which Angle is called the Ob-
liquity

E X P L A N A T I O N
Of the S O L A R D I A G R A M.

liquity of the Ecliptick, and since the Ecliptick and Equinoctial are both great Circles, they must bisect each other; as it is found they do, in the Beginning of Aries and Libra; so that six of these Signs lye on the North Side of the Equinoctial, and are called the Northern Signs; and the other Six, on the South Side of it, and are called the Southern Signs.—This Ecliptick is divided into $365\frac{1}{4}$ Parts, answering to the Number of Meridian Altitudes of the Sun, during the Revolution of the Earth thro' it, corresponding to the Number of solar Days or Rotations the Earth makes during that Time. As the elliptical Figure of the Ecliptick makes it five Degrees, and almost a Quarter longer than the Equinoctial, which is a Circle; so we find the Earth requires so much longer Time to traverse it, than she would require, did she go round the Sun in a Circle, at the same Distance from the Sun, she is at the Equinoxes; as the Earth makes equal Areas in equal Times. See Introduction, P. 16.

○.—New Moons; shewing the Day of the Month,

E X P L A N A T I O N
Of the S O L A R D I A G R A M

Month, according to the Julian Calendar, when the Sun and Moon are in Conjunction.

O.—Full Moons; *pointing out the Day of the Month when she is in Opposition to the Sun, in her Passage through the Ecliptick.*

S.—Sunday, or every Seventh or Sabbath-Day throughout the Year.

●.—The Earth, in the Meridian of the twelve Signs, in her Orbit, or Path through the Ecliptick, viz. when she has the Sun and these Stars in Conjunction, in her annual Orbit. Astronomers tell us that the Ecliptick is equally divided into twelve Signs of 30 Degrees each. But it is not so.—It is the Equinoctial which is divided equally by these twelve Signs.—Some of these Signs are of such a Length, as to require the Earth to make more than 31 Rotations while she is passing through them, while others require little more than 29; and the six Northern Signs are so much longer than the six Southern, that

B

the

E X P L A N A T I O N
Of the S O L A R D I A G R A M.

the Earth takes more than a Week longer in traversing them, than she does in traversing the others.—See Introduction, P. 16, 19.

E E—The Equinoctial, divided into twelve equal Parts, by the twelve fixed Stars, which are called Signs, each Sign into 30 Degrees; the whole Equinoctial containing 360 Degrees, answering to the same Number of Degrees on the Equator.

D D. — The Anticipation of Time. — This is not in Nature, but occasioned from the Julian Year not answering exactly in Length of Time, to the Length of Motion the Earth takes to perform her annual Orbit round the Sun, viz. the Julian Year contains $365\frac{1}{4}$ Days, whereas the Earth compleats her Revolution round the Sun, in 365 Days, 5 Hours, 49 Minutes.—Hence, as we calculate according to the Julian Reckoning, the Earth will finish her annual Orbit eleven Minutes of Time before the Julian Reckoning ends. *Introduct. P. 3, 97, 105.*
Thus

EXPLANATION

Of the SOLAR DIAGRAM.

Thus the Motion of the Earth anticipates Time, according to the Julian Calendar, eleven Minutes every Year, and throws it back.—See P. 98.—Let us postulate that Motion and Time, began, according to the Julian Period, at the autumnal Equinox, 706, (which is the Time the best Interpreters of Moses's History, say he placed it) from that Year to this, 1786, (which is the 6499th, according to that Period,) the Earth will have made 5793 annual Revolutions; by which Means, Motion will have anticipated Time 44 Days, 6 Hours, 3 Minutes, according to O. S. viz. from Oct. 25, to Sept. 11, or according to the N. S. from Oct. 25, to Sept. 22.

F. F.—The Precession of the Equinoxes. *According to the last Article, the solar or true Time, has fallen short of the Time, (as reckoned according to the Julian Calendar,) 11 Minutes every Year.—Hence, the Sun will appear eleven Minutes more forward in the Ecliptick, every Year, than she ought to do.—Thus, in 5793*
Revolutions,

EXPLANATION

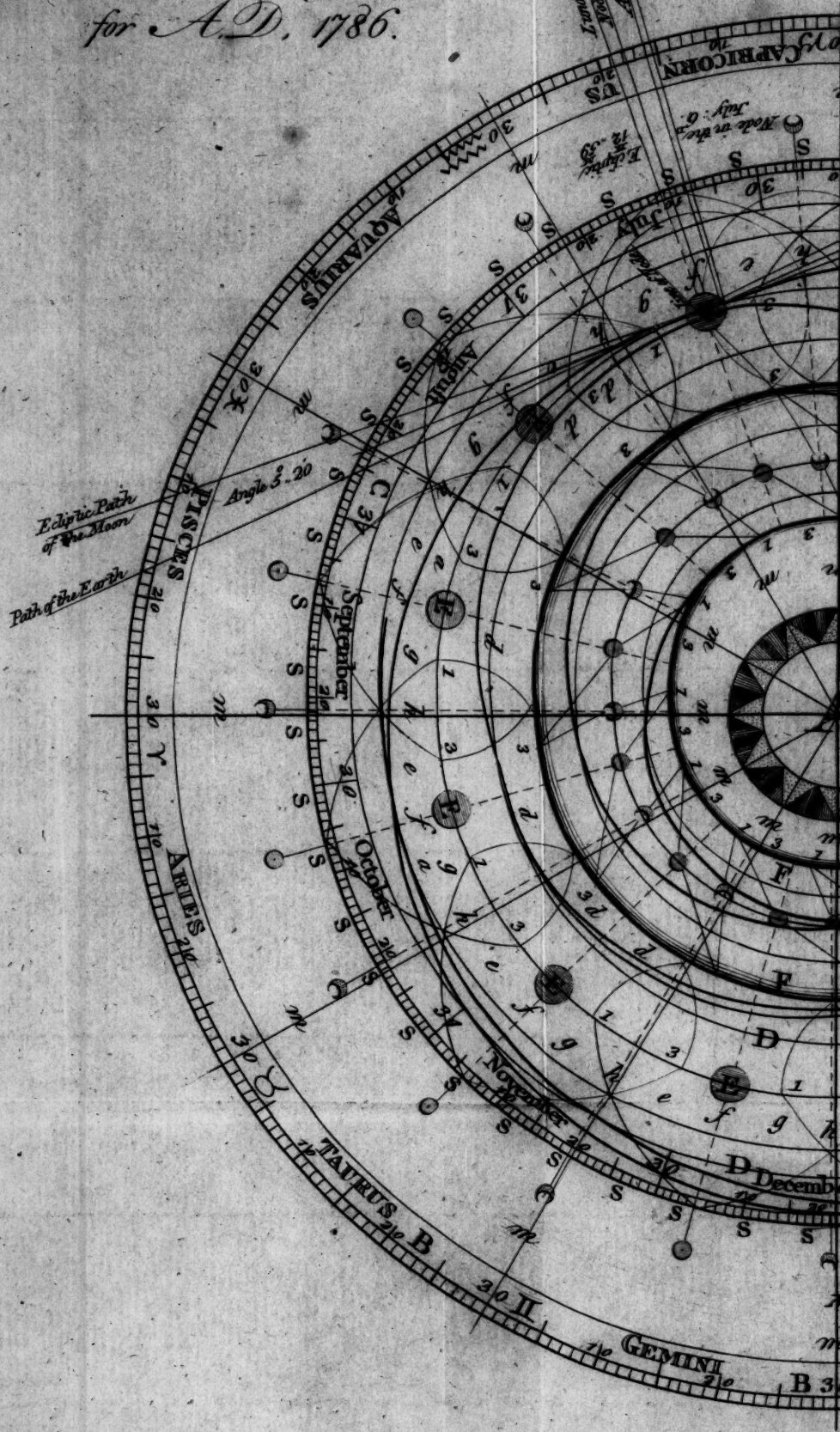
Of the SOLAR DIAGRAM.

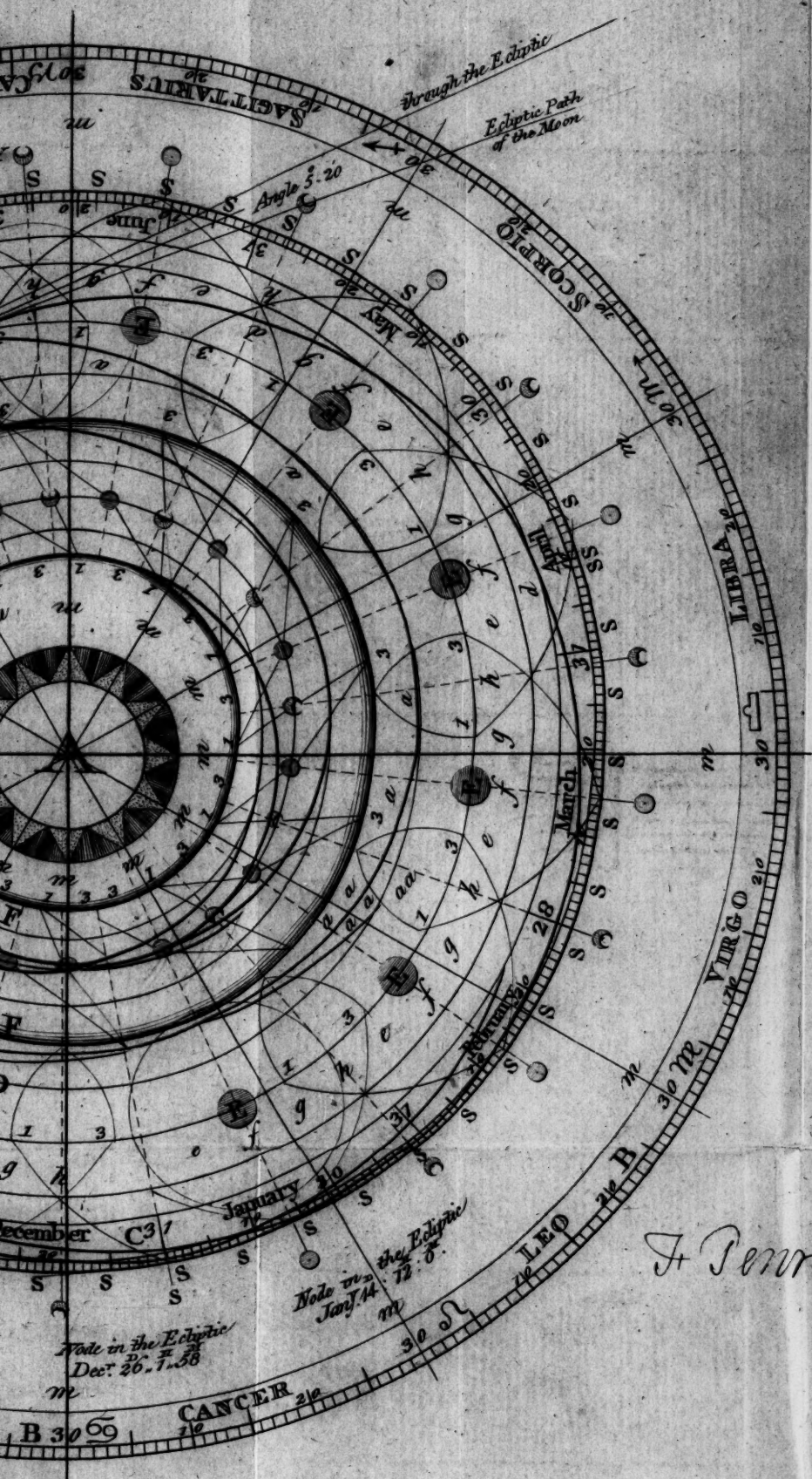
Revolutions, she will not appear to be in the Beginning of Aries, as she was observed to be A. I. P. 706, but in the third Degree of Taurus, (if we reckon by the N. S.) and in the 14th according to O. S. See Introduction, P. 98.

Hence it may be observed, that the fixed Stars and Equinoxes, are just in the same Places in the Heavens, they were 5793 Years ago, and that the Anticipation of Time, and Precession of the Equinoxes, are not in Nature, but occasioned by an erroneous Calculation of the exact Length of the solar Year and the lunar Cycle. See P. 97, 105.— This may be observed by G. G.— The Difference between O. S. and N. S. made A. D. 1752.

EXPLANATION

*A Lunar Diagram,
for A.D. 1786.*





An Explanation of the LUNAR DIAGRAM,
for A. D. 1786, (answering to the Year
of the World, 5793, and to the Year of
the Julian Period, 6499,) shewing the
Place of the Sun, Earth, and Moon, every
Day in the Year, according to the Julian
Calendar.

A.—*The Sun in the Centre of the System.*

B. B.—*The Equinoctial Circle, divided by
the twelve Stars or Signs, into twelve equal
Parts, of 30 Degrees each.—The Whole into
360 Degrees.*

(E) (E) *The Earth, in her Place in the
Ecliptick, when the Moon is at
Full, or in Opposition.*

C. C.—*The annual Path of the Earth round
the Sun, which is divided into Days, Weeks,
and Months, according to the Julian Calendar.
It is an Ellipse, within the Equinoctial, and
forms an Angle of 23 Days, 28 Minutes; with
it;—and is divided into $365\frac{1}{4}$ of Parts or De-
grees*

EXPLANATION

Of the LUNAR DIAGRAM.

grees, answering to the Number of Rotations the Earth makes during her Revolution round the Sun.—Was the Earth, throughout her annual Revolution, to keep at the same Distance from the Sun, which she is at the Equinoxes, she would then go round that Luminary in a Circle, and perform and measure it in 360 Days or Rotations.—But now, as it is performed by Nature, she goes so far beyond the Periphery of the Circle, at the Summer Solstice, as to require $5\frac{1}{4}$ more Rotations to do it.

m. m.—Meridians, which pass from the Sun in the Centre, to the first Point of each Sign, in the Equinoctial.—As the Circle of the Equinoctial and the Elliptical Path of the Earth, answer each other geometrically, so these Meridians cut the Julian Calendar at the true Day, and Month, when the Sun will be found to enter them; and thereby shew the Places of the Sun and Moon every Day throughout the Year.

*D. D.—The Moon's Orbit round the Earth,
E. going*

EXPLANATION

Of the LUNAR DIAGRAM.

E going forward through the Ecliptick.—This View is as it may be seen from a Planet or Star, without that Orbit, and perpendicular to the Plane of the Ecliptick.—By this Side View may be observed the Loops the Moon makes, in her Orbit round the Earth, in her Passage through the Ecliptick, (in the same Manner as other Satellites do round their Planets,) being sometimes a Semi-diameter of her Orbit before the Earth, and sometimes the same Distance behind her, always keeping about 240,000 of Miles from her, and going round the Ecliptick with her.—She is kept in her Orbit by two Forces, viz. the Light proceeding from the Sun, and the Light reflecting from the Earth.—This is the Power, (Light) which expands and projects her towards the Extremities;—the other is the Ether proceeding from the Extremities, which Sir Isaac Newton calls Spirit.—He often makes use of Attraction, to express the first, and Gravitation the last, without enquiring into the Causes of these Phenomena; therefore, to be short, clear, and better understood, I shall do the same.—See Let. IV. P. 165, XIV. P. 283.

E X P L A N A T I O N
Of the L U N A R D I A G R A M.

In her Orbit round the Earth, (which is about 240,000 Miles, from her,) these two Powers or Forces ballance each other.—Thus, here all is still, calm, and neither prevails.—Here also the projectile Force, which carries the Earth from West to East, through the Ecliptick, meets the gravitating Power, which carries the Moon from North to South, round the Earth. See Let. XVII.—As these two Powers act perpendicularly to each other neither prevails; but they act jointly, and they force the Moon round the Earth in a Diagonal between them.—Thus, at her Change, she goes N. W. till she comes to 1, (her first Quarter,) at which Place she is Half the Diameter of her Orbit behind the Earth.—Here, instead of going on N. W. she changes her Course, and goes nearly E. N. E. till she comes to her Opposition or Full, when she is due North of the Earth.—She continues still to go Eastward, but changes from E. N. E. to N. N. E. till she arrives at 3, (the End of her third Quarter,) where she is at the East Point of her Orbit, and a Semi-diameter of

EXPLANATION

Of the LUNAR DIAGRAM.

of her Orbit before the Earth.—From hence she goes Westward at S. W. till she comes to her Change, where she is due South of the Earth. See Let. XXII,

Besides the above described Forces, there is another which goes from West to East,—the ethereal Current of the Eclipses.—This Current goes from West to East, and round the Ecliptick, in a progressive Circle, but so slow as to require 18 Julian Years, 10 Days, 19 Hours, 46 Minutes, 0 Seconds, 15 Thirds, to complete it, and to meet the Moon again, exactly in the same Point of the Ecliptick from which they parted, when the Cycle began.—Hence, as Observations prove, at the End of this Cycle, there is a Return of all the Eclipses which touch the Earth.—Let. XXII.

Thus the Moon performs her Orbit, round the Earth, in 29 Days, 12 Hours, 44 Minutes, 1 Second, 45 Thirds, (which is called a Lunation,) in which Time the ethereal Current of Eclipses has moved forward and Eastward,

C

1 Day,

E X P L A N A T I O N
Of the L U N A R D I A G R A M.

1 Day, 14 Hours, 6 Minutes, 11 Seconds, 19 Thirds.—By which Means the Moon crosses that Current, before she comes to the Star.—This occasioned Astronomers to imagine that the Nodes moved backward to the Westward.—The Point where the Moon crosses the Current of Eclipses is called her Node.—At the End of every sixth Node, or 172 Days, 12 Hours, 59 Minutes, this Path of the Nodes crosses the ecliptick Path of the Earth, and if that Point is then within 17 Degrees of the Sun, it causes an Eclipse, but if farther from it, the Shadow of the Earth or Moon will not reach each other.

F F.—The Moon's Path, as observed from the Earth.—At the End of the first Quarter, she is Half illuminated.—At the End of her Second, she is wholly so.—At the End of her Third she is again Half illuminated; and at her last Quarter or Change, she appears quite dark.

S S.—The Sabbath, or Seventh Day throughout the Calendar.

The following is a Description of the
Eclipses

EXPLANATION

Of the LUNAR DIAGRAM.

Eclipses for the Year 1786.—January 14, at Noon, the astronomical Day ends, and January 15 begins; at this Point the Moon's Node was in the Ecliptick; and 44 Minutes after the Moon was opposite the Sun, and caused an Eclipse of the Moon.—To January 15, add six Nodes, or 172 Days, 12 Hours, 59 Minutes, and it will make 187 Days, 12 Hours, 59 Minutes; from this subtract the 181 Days from the Calends of January, and it will leave July 6th Day, 15th Hour, 59th Minute, the exact Place of the Node.—Six Nodes are short of six Lunations, 4 Days, 15 Hours, 25 Minutes;—this Node therefore will be in the Ecliptick so much before the Sun; and as the Nodes are diametrically opposite to each other, so the other will want just as much, and therefore meet the Moon in the Ecliptick, July 11th Day, 4th Hour, 24th Minute.—If we add six Lunations, or 177 Days, 4 Hours, 24 Minutes, to Jan. 15th Day, 0 Hour, 44th Minute, it will give July 11, 5, 8, for the Moon's Opposition, which is 44 Minutes only from the Node, and will cause a total Eclipse of the Moon, but, as
it

EXPLANATION

Of the LUNAR DIAGRAM.

it happens about five o'Clock in the Afternoon, must be invisible to us.—In 14 Days, 9 Hours, 4 Minutes, (Half the Length of a Node,) the other Node will get round the Earth into the Ecliptick, which added to July 11th Day, 4th Hour, 24th Minute, brings it to July 25th Day, 13th Hour, 28th Minute.—In Order to find when the Moon will be in Conjunction, add Half a Lunation, 14 Days, 18 Hours, 22 Minutes to July 11th Day, 5th Hour, 8th Minute, (the Time when the Moon was in Opposition,) it will cause an Eclipse, but not visible to us.

In Order to find when the Node will again cross the Ecliptick, add 345 Days, 1 Hour, 58 Minutes, (the Quantity of twelve Nodes,) to Jan. 15.—It will bring it to Dec. 26th Day, 1st Hour, 58th Minute, when the Node will again be in the Ecliptick; but as neither Node will then be within 20 Degrees of the Sun, no Eclipse can happen.

a, a, a.—The Path of the ascending Node.

d, d, d.—The Path of the descending Node.

CONTENTS.

INTRODUCTION.

S*SOME* Notions in these Letters contrary to
general received Opinions. Page 2.

*Equinoctial equally divided by the twelve Signs,
but the annual Orbit of the Earth unequally,
and measured by the Number of Rotations the
Earth makes during that Time.* 3

*Retrocession of Time, how occasioned; shewing
the Cause of the Difference between Calendar
Measure and true Time:—Chronology of Time
when began: 4, 98—Style altered.* 5

*Time when it began; that Point described by
Moses.* 6

*Certain Points from which Astronomers be-
gin their Computations, as described by Dr.
Keil.* 7

Creation when it happened. 6, 8

*Observations of some eminent Astronomers on
the Diagrams, with their Remarks thereon.*
10, 342

C O N T E N T S.

I N T R O D U C T I O N.

	Page
<i>Remarks on the Astronomers Remarks.</i>	13
<i>The Reason why the Seasons of the Year have not been pointed out, exactly, by any Nation besides the Israelites and Jews</i>	14
<i>Olympiads described.</i>	15
<i>The Revolution of the Equator, the only true Measure of Time.</i>	16
<i>Annual Orbit of the Earth round the Sun, an Ellipse, and divided unequally.</i>	16
<i>Time and Motion answering exactly to each other; both measured by the Rotations of the Equator, and answering each other precisely, so that they may be turned into each other reciprocally.</i>	17
<i>The Quantity of Time the Earth goes forward in the Ecliptick, during one Rotation of the Earth, or a natural Day.</i>	42

All

CONTENTS.

INTRODUCTION.

	Page
<i>All Nature measured by the Rotations of the Equator.</i>	18
<i>The Division of the Ecliptick examined, and the Length of the Solar Year.</i>	19, 20
<i>Observation thereon, only one Year apart, precarious.</i>	21
<i>Dr. Keil's Method of ascertaining the Length of the solar tropical Year.</i>	22
<i>The Length of it examined and proved, by Mr. Kennedy, according to Dr. Keil's Method, from Observations made 168 Years Distance from each other.</i>	23
<i>Solar Period, or Cycle of the Sun described.</i>	24
<i>Dr. Bradley's Observation, A.D. 1753, ascertained the first Meridian.</i>	25
<i>Calendar of the Israelites described, and the Method</i>	

CONTENTS.

INTRODUCTION.

	Page
<i>Method they used to measure and record Times, viz. by Days and Years.</i>	26
<i>Though the Israelites appear to measure Times and Seasons mechanically, yet they do it at the same Time, astronomically, according to the Operations of Nature.</i>	30
<i>The Method of calculating Times and Seasons by the Israelites.</i>	31
<i>The Year of the Quadriennium at the Creation.</i>	34
<i>The Method of adjusting the lunar with the solar Year, by the Epact, and both measured by integral Days.</i>	36
<i>The solar Months of the Israelites, agreeing with the twelve Signs, beginning and ending on the same Point with them.</i>	38
<i>The Use the Israelites made of their solar Months, and the Courses of their Priests described.</i>	39

CONTENTS.

INTRODUCTION.

The Beginning of the Year, the Month, and the Week altered by the Command of God, as a Memorial of their Deliverance from the Egyptian Bondage.

Page 41

The Jews, in celebrating their Feast, for their Deliverance from the Egyptian Bondage, celebrate the Birth of Christ also.

41

The true Time of the Birth of the Messiah examined, and found to be at the Feast of Ingathering and Tabernacles.

42

How it happened that Christians kept the Birth of Christ at the Winter Solstice, instead of the autumnal Equinox.

45

The Julian Year, when it began.—The Cause why Julius Cæsar altered it, and the Method of that Alteration.

50

The Names and Animals, denominating the twelve Signs, ideal, and descriptive of the Seasons,—whence derived.

53

D

Agency

CONTENTS.

INTRODUCTION.

Agency of Nature believed by the ancient Philosophers, to be in Heat and Cold. Page 60

The Death of the Messiah foretold by Daniel; this Prophecy examined. 65

The issuing of the Decree for the Return of the Jews to Jerusalem, and the End of the Prophecy compleated, by the cutting off the Messiah. 67

When the Paschal Lamb was to be slain. 70

The old seventh Day Sabbath restored ; — the Birth of Christ, how kept. 71

The aforesaid Observations proved by the Calculations of Equinoxes, new and full Moons, and Eclipses.—Deists and Skepticks called on to point an Equinox, new or full Moon, or an Eclipse, which contradict it. 74

The Point where these Calculations were began. 74

Why

CONTENTS.

INTRODUCTION.

*Why the Introduction was dated Sept. 22,
1787.* Page 76

*The Age of the World, and Day of the Week,
proved mathematically and astronomically, by the
Number of Days, Years, and Lunations.* 78

*A Calculation of the Eclipse which happened
during Herod's last Illness.* 79

Calculation of the Birth of Christ. 82

*Prophecy of Christ's Death foretold and cal-
culated.* 85

*A Calculation of the Eclipse, A. D. 1787,
also of the next Full Moon after it.* 92

*Explanation of the aforesaid Calculations;—
their Method described, with Instructions how
they were performed.* 97

*Difference between Calendar Measure and
true Time, explained by Dr. Keil.* 98
Lunar

C O N T E N T S.

Lunar ANTICIPATIONS explained and proved to have no Foundation in Nature. P. 104

The 19 Years Cycle of the Moon proved to be longer than the 19 Years Cycle of the Sun, which is contrary to the general received Opinion of Astronomers. 105

Issue joined with the Skeptick, to try whether what is asserted, (viz. that Moses gives us the Place of the Sun and Moon at the Creation) be true or not.

What gave Occasion to the following Letters. 118

L E T T E R I.

On the D E L U G E.

An Answer to some Queries proposed by Mr. Heavyside ;—whether Ore, Metal, or Coal were ever found under Chalk?—Observations where Ore and Metals are found, with Remarks on the Formation of this terraqueous Globe.—How Metals, Salts, &c. were dissolved, and reformed at

C O N T E N T S.

at the Deluge; together with the Method by which the different Strata were formed.—The Flood described. Page 119

L E T T E R II.

On the D E L U G E.

Mr. Heavyside's Answer to the former Letter, with his Remarks thereon; together with his Theory of the Deluge.—That he cannot think that the Earth underwent a general Dissolution at that Time.—That he believed the central Nucleus was Fire;—with Objections to the Dissolution of the Earth at the Deluge. 130

L E T T E R III.

On the D E L U G E.

Facts which prove that in all Parts of Europe, Asia, Africa, and America, the Exuviae of Animals and Vegetables, particularly Sea Shells, are found in different Strata of Stone, both on the Tops of the highest Mountains in the World, and also at the greatest Depths that have been

C O N T E N T S.

*been dug below the Surface of the Earth.—
Some farther Account of the Deluge. Page 137*

L E T T E R IV.

On the C R E A T I O N.

Original Names, ideal.—The Reason why it has been asserted and generally believed, that the Scriptures do not speak strictly true, with Regard to Philosophy, on the Motion of the Sun, Earth, &c. but is accommodated to vulgar Apprehensions.—The Mosaic Account of the Creation and Formation of this System;—describing the Agents which carry on the mechanical Operations of Nature; together with some Extracts from Sir Isaac Newton, to shew that he supposed the Agents of Nature to be the same as those revealed in the Scriptures.

145

L E T T E R V.

On V E G E T A T I O N.

*Vegetation, when it first began.—The Agents which carry it on described; together with the
Method*

C O N T E N T S.

*Method Nature makes use of for that Purpose.
The Vegetation of a Seed and Bud.—Experiments from Dr. Hales, to ascertain the Effects of Heat and Cold on that Operation of Nature.*

Page 167

L E T T E R VI.

On V E G E T A T I O N.

Experiments from Dr. Hales, which prove that Vegetables inspire and expire according to the Dryness and Moisture, and the Heat and Coldness of the Air.—The Method Nature makes use of to perform Vegetation.—Trees and Vegetables grow in the Form of a Pyramid, unless prevented.—The Cause assigned why Plants in a Green-house, or other Room, point towards the Window.—The Juices of Vegetables always in Motion, but do not circulate like the Blood in Animals.—Some more Experiments from Dr. Hales, to explain the Method Nature makes use of in the bleeding Season, (in the Spring of the Year) to force out the Buds and Leaves. 184

LETTER

C O N T E N T S.

L E T T E R VII.

O n V E G E T A T I O N.

A Recapitulation of the Method Nature makes use of to carry on Vegetation.—The natural Agents hot and cold Ether.—Fire and Motion synonymous.—The Phenomenon of Vegetation a proper One to explain the Agency of Nature. The Cause why Trees shed their Leaves in Autumn, and the Means made use of to push forth their Buds and Leaves in the Spring.—The Scripture Account of Vegetation perfectly agreeable with Nature.—Cold and hot Ether, the Agents which support and carry on Animal as well as Vegetable Life.

Page 203

L E T T E R VIII.

O n the D E L U G E.

Mr. Heavyside professes a great Inclination for the Study of Natural Philosophy, though he had been prevented from attending to it so much as he wished.—He then puts the following Query. In that general Dissolution of Substances, which
you

C O N T E N T S.

you suppose at the Deluge, why were not Shells, Bones, Shrubs, &c. dissolved, as well as Rocks, Stones, &c.? Page 216

L E T T E R IX.

On the D E L U G E.

Prejudices of Education hard to be overcome, therefore many Things in Mr. Penrose's Theory may appear doubtful at first, as they differ from some which are generally taught.—There may be Arcana in Nature, which human Reason may not be able to explain.—Answer to Mr. Heaviside's last Query.—A Constitution and Custom observed by the Royal Society, concerning Disquisitions.—The Waters outside of this terraqueous Globe, not sufficient for the Flood.—Centre of Gravity altered at the Flood.—Causes assigned why Bones, Shells, &c. were not dissolved. 220

L E T T E R X.

On CHRONOLOGY and ASTRONOMY.

As the first material Agents cannot come within the Knowledge of our Senses, so different
E Philosophers

C O N T E N T S.

Philosophers have formed different Opinions; but Astronomy may be proved by mathematical Demonstration.—History is no more than a Romance without Chronology, which is not certain unless proved by Astronomy.—Where to begin our astronomical Epoch.—Moses's Account of the Place of the Sun and Moon at the Creation, proved by mathematical Demonstration.—First Meridian proved by an Observation of Dr. Bradley's.—As Mr. Penrose is not fearful of being convicted of Error, Leave is given to Mr. Heaviside to shew this Letter to any Proficient in Astronomy, and to get his Criticisms on it.

Page 231

L E T T E R X I.

On CHRONOLOGY and ASTRONOMY.

*Mr. Heaviside having shewn Mr. Penrose's Letter to some eminent Astronomers, Members of the Royal Society, they “ all agree that his
“ Calculations were perfectly right, and proved
“ what he intended they should; and that they
“ would have desired Leave to have read the
“ Paper at the Meeting of the Royal Society,
but*

C O N T E N T S.

*“but that it was deemed to be connected with
“religious Subjects, which they never meddle
“with there.”—Queries to Mr. Penrose, oc-
casioned by the aforesaid Letter. Page 241*

L E T T E R XII.

On CHRONOLOGY and ASTRONOMY.

*Moses's History of the Creation ought to be
examined by Chronology and Astronomy, which
is the true Test of History.—The Cycle of Years
explained.—Answer to Mr. Heavyside's last Que-
ries.—Ether the Cause of Gravitation.—Gra-
vity and Levity relative Terms.—The Agency
of the Ethers explained;—they are the Cause of
Winds, Hurricanes, Earthquakes, &c.—They
alter or destroy Attraction, Gravitation, Co-
hesion, &c.—Is the Cause of the different Mo-
tions of the Earth, and its spheroidical Shape.—
The Cause of Tides, &c. 247*

L E T T E R XIII.

On NATURAL PHILOSOPHY.

*Doubts proposed concerning some Parts of
Mr.*

CONTENTS.

Mr. Penrose's Philosophy, in Order that Truth may be ascertained.—Queries concerning cold Ether, and the Pressure of that cold Ether into the hot, or where it is more rare.—What is the Cause of the Motion of the Earth? What is the Cause that the Earth does not fall into the Sun? Do you impute it to a Current of Ether? Answer to the last Queries conclusive, if it be allowed that Moses was so far ignorant of Astronomy, as to be incapable of calculating the Eclipses which preceded his Time.—He is said to be learned in all the Learning of the Egyptians. State of the Sciences in Chaldea and Egypt.

Page 263

LETTER XIV.

ON NATURAL PHILOSOPHY.

Mr. Heaviside's Query answered.—Calculations of the Motions of the heavenly Bodies demonstrably true; but the Principles of natural Philosophy cannot be demonstrated with that Clearness and Precision, as those in Astronomy. Three Principles of Matter;—Gravity explained.—Cold and hot Ether described according to

Sir

C O N T E N T S.

Sir Isaac Newton.—*Centre of Gravity supposed formerly to be placed in the Centre of the Earth, but late Experiments prove that Gravity does not tend to the Centre of the Earth, but to the Superficies, and to the Place where there is the greatest expansive Heat.—Gravity proved to be increased or lessened in Proportion as Heat and Cold prevail.—The Pressure of the cold Ether or Gravity acts exactly in the same Proportion on the Poles and the Equator, as the spheroidical Shape of the terraqueous Globe shews it does.—The Centre of Gravity to be near the Surface of the Earth, where every Thing tends.*

Page 271

L E T T E R X V.

O n N A T U R A L P H I L O S O P H Y.

State of the Sciences about two thousand Years ago.—The former Query repeated, “If the Earth, &c. were first put in Motion by the Heat of the Sun, rarefying the Atmosphere between these Bodies, why did not the Earth immediately gravitate into the Sun? Must not a trajectile Force have been first necessary to cause its annual Orbit?”

293

L E T T E R

CONTENTS.

LETTER XVI.

ON NATURAL PHILOSOPHY.

Heat and Cold first Agents, according to Sir Isaac Newton, Boerhaave, &c. — Internal Make of this terraqueous Globe described. — The Thickness of the Shell of the Earth. — The confused Appearances on this terraqueous Globe, prove that it has underwent tremendous Convulsions from within, and that the earthy Shell has been burst into Millions of Pieces. — Earthquakes examined, and their Effects described. — These Effects occasioned by Fire. — The Causes of Earthquakes explained; which prove that there is an immense Quantity of Fire within the Earth. — The above Account agreeable with what is given in the Scriptures.

Page 299

LETTER XVII.

ON NATURAL PHILOSOPHY.

Mr. Heavyside's Question, "Why does not the Earth gravitate into the Sun, &c." answered. All Space filled with ETHERS, which reach from the Sun to the Extremities of this System, and

C O N T E N T S.

and are in continual Conflict, and cause a vibrating Motion, by their Endeavour to get the better of each other.—These Ethers the Cause of Projection and Gravity.—The Earth and Planets of different specifick Gravities, according to their Distances from the Sun.—The diurnal and annual Motion of the Earth accounted for.—The Phenomena of Nature, and the Scriptures, confirm the Testimony of each other.

Page 321

LETTER XVIII.

On ASTRONOMY.

With a D I A G R A M. 337

LETTER XIX.

On ASTRONOMY.

Observations of Mr. Heavyside's astronomical Friend, on Mr. Penrose's Diagram, not conclusive.

339

LETTER XX.

On ASTRONOMY.

*Mr. Penrose's Design to get the Opinion of
some*

CONTENTS.

Some of the Geometricians and Astronomers, concerning his Diagram. Page 343

LETTER XXI.

On ASTRONOMY.

The Difficulty in getting a decided Opinion on the Diagrams. 347

LETTER XXII.

ASTRONOMY.

On the MOON and LUNAR MOTIONS.

The Moon not a Planet, but a Satellite attending the Earth.—The recorded Observations of Astronomers, concerning her, collected.—Her Make and Motion described.—The Chaldean Cycle, with the Methods they made use of for calculating their Eclipses.—The physical Causes of these Motions explained, and confirmed by the Observations of Mr. Herschel, and the French Astronomers. 349

LETTER XXIII.

CONTENTS.

LETTER XXIII.

ON ASTRONOMY.

To confirm what Mr. Penrose has observed in his last and former Letters.—He has sent Mr. Heavifide a Calculation of the Eclipse which is to happen July the 25th.—It is calculated by the Method made use of by the Ancients, to measure and record Time:—But to shew how certain their Method was, it is also calculated according to the present, by Equations and Anomalies.—It may be remarked, that both these Methods differ from each other only 8 M. 11 S. That the Patriarchs and Chaldeans had more Knowledge in Astronomy than is generally allowed them.—This is proved by the 18 Years Cycle of Eclipses, and also the 19 Years Cycle of the Moon, both which, it is certain, we received from them, and without these Cycles, Astronomers would be at a great Loss.—Data on which the Calculations are made, and Conclusions inferred from them.

Page 380

Introduction.

The Committee on the part of the
 Government has the honor to acknowledge
 the receipt of your letter of the 18th inst.
 and in reply to inform you that the
 same has been forwarded to the
 proper authorities for their consideration.
 Very respectfully,
 J. M. Smith, Secretary.

The INTRODUCTION.

THE following Letters are real Copies of genuine ones, which passed between me and an intimate Friend, for our own Amusement, according to their Dates; but not with the most distant View that they should ever appear before the Public.—The Gentleman,* who was the first Beginner of this Correspondence, died about the Middle of last February.—Some Days before his Death, he desired his Son to write me, that

A

“ He

* JOHN HEAVISIDE, Esq. of Princes's-Street, Cavendish-Square; a Gentleman whose Loss is already experienced by many of his Acquaintance, who were very numerous; his whole Attention, for many Years past, having been employed to serve his Friends and Neighbours, particularly those in Distress; this was his greatest Pleasure! and he had Inclination, Fortune, and Abilities to do it.—Therefore, as a Person of his unbounded Benevolence is so rarely to be met with, his Loss will be the more severely felt.

2 *The* INTRODUCTION.

“ He was past all Hopes of Recovery, and
“ begged to know what I would have done
“ with those very valuable Papers which he
“ had of mine, his Health having made him
“ unable to attend to them as he wished.”
About ten Days after this, the Son wrote me
a second Letter, “ to let me know that his
“ Father was dead, and that he had found
“ the Letters of mine which his Father or-
“ dered should be sent me.”

Some Time after this, I mentioned his
Death to some of our Friends, with the Cir-
cumstance of his Son's sending me some Let-
ters which had passed between us.—They
desired to read them; after which they re-
turned them to me again, with a Request
that they might be printed; I consented
thereto, and hope they will receive the Ap-
probation of the Public.

As some of the Notions in these Letters
are contrary to *general received Opinions*, I
trust they will not be discarded on that Ac-
count, without being first examined, and the
Evidence

The INTRODUCTION. 3

Evidence I produce tried, if sufficient to support these Notions or not ; which are, principally,

First, That the Equinoctial, or great Circle of the Heavens, is equally divided by the twelve Signs, of 30 Degrees each, making in the Whole 360°.

Secondly, That the annual Orbit of the Earth must be measured by the Earth's rotary Motion, which is absolutely, and without any Exception, the true Measure of Time.

Thirdly, That the Anticipation of Time, and the Precession of the Equinoxes, have not any Foundation in Nature, but are occasioned by the Calendar Computation, not answering exactly to the Length of the annual Orbit.— According to our Calendar Measure, the solar Year contains $365\frac{1}{4}$ Days, or Six Hours ; but the solar tropical Year, or the Time she is performing her annual Orbit, is only 365 Days, 5 Hours, 49 Minutes, which

4 *The INTRODUCTION.*

which is 11 Minutes short of her Quadrant, or six Hours. Therefore the Earth precedes, beyond the Meridian, where it began, 11 Minutes in equatereal Time, or $2^{\circ} 45'$ in Measure. Hence, as the Earth goes, every Year, 11 Minutes beyond the Place where it began; so it had occasioned, (in the Year 1753) the Equinoxes to have preceded forward 44 Days, and the Calendar Computation to fall back the same Number; and thereby to anticipate Time so much. For the Autumnal Equinox, in the Year 706, of the Julian Period (which was the Year of the Creation, according to the Mosaic Chronology) fell on October 25th; but in A. D. 1753, which was the 6466th of the Julian Period, it was observed to enter Libra, Sept. 11, O. S. so that in 5760 Years, the Calendar Measure had *anticipated* the true 44 Days.

At the Council of Nice, which was held A. D. 325, the Sun was observed to enter Libra, Sept. 22; therefore in order to bring the Calendar Measure back to that Time, and so to commemorate the Festival of Easter,
at

at a more exact Season; an Act of Parliament was passed, A. D. 1752, to throw 11 Days out of the Calendar Computation for that Year; so that this Year contained only 354 Days, instead of 365. By this Means the Equinox was brought back from the 14th of *Taurus* to which it was got, (from the first of Aries,) to the third of the same Sign, and the Sun entered *Libra* that Year, Sept. 22, N. S. instead of Sept. 11, O. S. which was the Time it entered it the Year before. (a)

Fourthly; The general Opinion is, that Moses, in his History of the Creation, does not point out, or give us any Instruction, in what Place of the Heavens the Sun and Moon were at the Creation.

First.—In answer to this I observe, that he has told us, 1st, That they were placed there on the fourth Day of the Creation Week.

2dly

(a) See Letter XII. XIV. and Diagrams.

6 *The* INTRODUCTION.

2dly.—That the Moon could not give her Light till the going down of the Sun: As the Sun was in the Meridian of the Place where it began to shine; so the Earth must have made one Quadrant of her Rotation, before the Moon could enlighten Her.—As soon as that was performed, the Sun sat in the West, and the Moon rose directly after in the East, when they both together enlightened the whole Earth from Pole to Pole. Hence, it may be remarked, that the Rotation of the Earth measured one Quadrant of solar Time, before she began to measure the lunar; therefore as the Sun and Moon were, jointly, to point out the Seasons, the Days, and the Years; so the Chronology of Time must begin at this Period, as Moses tells us it did.

(b) 3dly.—In Regard to the Place of the Sun and Moon in the Heavens, Moses informs us, that the Feast of Ingathering at the End or Revolution of the Year, was to commemorate the Creation, which happened
at

(b) Levit. XXIII, 34.

The INTRODUCTION. 7

at that Season.—That the Feast was to be kept at the autumnal Equinox.—That the Moon must begin to shine in the Evening, at the going down of the Sun, being fifteen Days old, and just passed her Opposition or Full.—Here then we have a Point to begin our Calculations from, viz. the first Degree or Point of Libra; the Epact 15, (the Moon then being fifteen Days old) the fourth Day of the Week; and, as one Quadrant of solar Time was to be added to the Beginning of the Year, viz. from twelve o’Clock MIDDAY, to Six in the Evening; so it must be the second Year of the solar Quadriennium.—Had we not had these *Data*, we must be in the Dark for a Point where to begin our Calculations from; for, as Dr. *Keil* observes, Lect. XXVIII. “As there are certain Points from
“ which Astronomers begin their Computa-
“ tions of the Planets Motions, so also there
“ must be certain Points, as Instants of Time,
“ from which, as from Roots, all Calcula-
“ tions must begin.”

Now, I have postulated that my Interpretation

8 *The* INTRODUCTION.

pretation of the Mosaic History is true; and I find by Calculation, that all the Equinoxes, Solstices, new Moons, full Moons, and Eclipses, will be pointed out by these Calculations, according to the observed Times. Here then we have two Points to measure from, 1st. the postulated Point of the full Moon, at the autumnal Equinox 706, according to the Julian Period; and 2dly. the observed Time, when the Sun entered Libra, A. D. 1786, which Year we know answers to the Year 6499 of that Period; during that Time the Earth has made 5793 annual Revolutions through the Ecliptic, and 2115849 Rotations round her Axis. Therefore, it must be allowed, that if the Number of the Earth's Rotations (or natural Days) and the Number of Years, or annual Revolutions, measure the exact Length between these two Points, it must be mathematically true.—Now, I prove by Calculations (c) that they do.—These Calculations have

(c) See Letter, No. XVII.

The INTRODUCTION. 9

have also this farther Evidence, *viz.* That you may begin them, either at the autumnal Equinox, 706, A. I. P. or when, (by Observation,) the Sun was seen to enter Libra, A. D. 1786, and the Calculations will come out the same to a Minute, which no astronomical Tables, yet extant, will do.—During this Time, the Moon will have made 71647 Lunations or Revolutions round the Earth, and Half another, when She intersected the Earth's Orbit, through the Ecliptic, and caused an Eclipse of the Sun, A. D. 1786, July 25 D. 8 H. 43 M. P. M.

If, after this, any one should dispute the Point, whether Moses has given proper Instructions concerning the Place of the Sun and Moon, the Day of the Week, &c. at the Creation.—He must allow that we have been very lucky in getting Information for doing it. (d)

These Notions being different from those
B adopted

(d) See Letter, No. XVII.

adopted by Writers on the Subject, I remained diffident of my own Opinions, notwithstanding my Calculations of the Motions of the Heavenly Bodies, confirmed me they were true, till I desired Mr. Heavyside, who had some Friends among the Royal Society, eminent in Astronomy and Philosophy, to shew them these Letters, with my Diagram, and to get their Opinions and Remarks on them.

The Gentlemen returned him for answer, that I had proved, to Demonstration, that the Sun and Moon were in the same Places in the Heavens, in the Year 706 of the Julian Period, (as they must have been in the Year in which the Creation happened, according to the Mosaic Chronology,) and that the Earth had made just the same Number of Rotations, which I had postulated it had. But with Regard to those Points in the Diagram, wherein I differed from the general received Opinions, they did not determine.^(e)
That

(e) See Letter VII.

The INTRODUCTION. 11

That they liked my Letters so well, that they would have read them before the Royal Society, had they not been joined with Religion, which was contrary to one of their Rules to enter on.

Not receiving the Satisfaction from those Gentlemen I hoped for, concerning the Points wherein I differed from general received Opinions, I got another Friend, who was intimately acquainted with an eminent Astronomer, to request his Remarks thereon; to whom I also sent one of my Diagrams.— After some Time, he sent his Remarks in the following Words, “ I have examined
“ some Parts of it, and find it to be sufficient-
“ ly exact; I must however observe, that the
“ Method of representing the Sun’s Place,
“ and also the new and full Moons, for a
“ given Year, by a Diagram, is by no Means
“ new; since not only that has been done,
“ but, by certain moveable Circles, the Lu-
“ nations and Seasons of the Eclipses have
“ been shewn for a given Number of Years.
“ There are, however, several Assertions in
“ the

“ the Explanation which accompanies the
 “ Diagram, which, I believe, will not be
 “ readily granted.—The Constructor of the
 “ Diagram, says— *Astronomers, tell us, that*
 “ *the Ecliptic is equally divided into 12 Signs,*
 “ *of 30 Degrees each; but it is not so.*—Now
 “ the Truth is, that the Ecliptic is equally
 “ divided by the twelve Signs, and when
 “ these twelve Signs are *referred* to the Equa-
 “ tor, they necessarily occupy unequal Por-
 “ tions of that Circle, from the Inclination
 “ of the *two Circles.* ^(f) Besides, the Ecliptic
 “ *cannot with any Propriety,* be called an
 “ Elipse.—It is *only* the Line described ap-
 “ parently by the Centre of the Sun, viewed
 “ from the Earth, during the annual Revo-
 “ lution of that Planet round that great Lu-
 “ minary.—That I am not at all disposed to
 “ enter into any Discussion concerning the
 “ Accuracy either of the ancient Israelites, or
 “ the modern Jews, in calculating the Times
 “ of their Feasts.—I must however observe,
 “ that the Length of the tropical Year is not
 “ exactly

(f) The Equator is a Circle—The Ecliptic an Elipse.

“ exactly 365 D. 5 H. 49 M. but is at present a few Seconds shorter, and has been continually diminishing, somewhat unequally, for several Centuries past; and will, in all Probability, continue to diminish for many Ages to come.”—On this I beg Leave to remark, that there, certainly, have been formed very exact Diagrams, representing the Sun’s Place, &c. for a given Year—But then these have been made by the Assistance of Equations and Anomilies, to make the 365 Rotations of the Earth, to tally with the 360 Degrees of the Equator.—Thus, as he has very justly observed, when the 365 Rotations of the Earth, through the Ecliptic, is referred to the Equator, they necessarily occupy unequal Portions of that Circle, so unequal as 365 is to 360. From which it is agreed, that a Diagram has been formed to shew the Sun’s Place, &c. in a given Year, by the *artificial* Means of *Equations* and *Anomilies*; but mine, on the contrary, is formed according to Nature; that is, by the Rotations of the Equator *only, the sole Measure of Time*, without Equations or Anomilies.—I will

14 *The* INTRODUCTION.

will now beg leave to remark, that Moses in his History tells us, that the Sun and Moon were *both* placed in the Heavens, to measure and point out the Seasons, the Days, and Years : (g) Hence the Reason why those Nations who have made Use of one of them *only*, have never yet been able to keep the appointed Seasons of the Year they were designed or instituted for.

The only ancient People, whose History can be confirmed by true Chronology, and proved by Astronomy, were the Israelites, whose Years were formed by the Sun and Moon, jointly.—That is, the Moon, by intersecting the Earth's Orbit, prevented the Beginning of the solar Year going from the appointed Season ; their Year always ended at the first full Moon which happened either upon, or, the first which succeeded, after the

(g) Gen. I. 14. Moses says, that the Sun and Moon were jointly appointed to measure, mark, or point out the Times and Seasons ; for God said, let them (in the Plural) be for Signs, and for Seasons, and for Days, and Years.—The Scriptures farther inform us, Psalm LXXXIX. 37, and CIV. 19. That the Moon is established in Heaven as a faithful Witness, to point out the Seasons.

the autumnal Equinox.—In Imitation of this, were formed the Olympiads of the Greeks, who followed the Posterity of Abraham in this Particular, *viz.* by governing the Seasons of the solar Year, by the Moon's Intersections of the annual Orbit of the Earth; indeed they differed from them in ending their solar Year at the Summer Solstice; whereas the Israelites finished theirs at the autumnal Equinox.—Thus the Chronology of Years was truly recorded by the Olympiad Games, which were celebrated every four Years, on the first full Moon which happened upon or after the Summer Solstice.—By this Means they kept the Beginning of their Years at the true Seasons; and this no other Nation has been able to do, notwithstanding the great Improvements which have been made in Opticks and other Sciences; neither will it be done *now*, by the *Gregorian* Calendar, which will vary more than an Hour in one Hundred Years.

With Regard to the Measure of the Earth's annual Orbit, through the Ecliptic, whether

or .

16 *The* *INTRODUCTION.*

or not it is equally divided by the twelve Signs, of 30 Degrees each ; let it be remembered, that the rotary Motion of the Earth is the *only* Measure of Time, and that every Rotation of the Equator is 360 Degrees, *in Measure*, and 24 Hours *in Time*.— Now when the Sun is in Conjunction with any one of the Signs, suppose *Libra*.—The annual Orbit is measured by the Number of Rotations the Earth makes during her Passage through the Ecliptic, or till the Sun is in Conjunction with the same Star, *Libra*, again.

Had the annual Orbit of the Earth been a Circle, instead of an Elipse, (as the Earth performs equal Areas in equal Times,) these twelve Signs would have equally divided the annual Orbit, as well as the great Circle of the Heavens, and all concentrick Circles ; but as it is not a Circle, but an Elipse, and that Part of the elliptic Orbit which the Earth traverses in Summer, being much larger and farther from the Sun, than the other Half which it traverses in Winter, must, of Consequence,

sequence, make a greater Number of Rotations in going through that Half than the other; indeed by Observation we find it to be more than seven.

The Earth measures the Orbits of all the Heavenly Bodies, as well as her own annual Orbit, by the Number of Rotations she makes during those Orbits, and adding the Overplus of Degrees beyond the last Rotation.—For this Purpose, the whole Equator, or Circumference of the Earth, is, as has been observed, divided into 360 Degrees in Measure, whilst she makes one Rotation round her Axis, from Sun to Sun, and is called a solar or natural Day; which 360 Degrees in Measure, are divided into 24 Hours, by a well regulated Clock.—Hence it may be observed, that, as every Rotation of the Equator contains exactly 360 Degrees, whilst a well regulated Clock points out 24 Hours in Time, *precisely*; so Time may be turned into Measure, and Measure into Time, reciprocally.—This has been evinced to Demonstration by the Trials of Mr. *Harrison's* Time

Piece. —While the Earth is performing this Rotation or natural Day, She is carried forward, four Minutes of Time, in her annual Orbit. viz. That Space of Time which She takes in going from the Star She sat off from the Day before, (which was then in Conjunction with the Sun) till She comes in Conjunction with the Sun again, is just four Minutes.—But this is a different and distinct Motion of the Earth's, *forward*, in its annual Orbit, which has no other Connection with the diurnal Rotation, than that it is measured by a stated Part of that Rotation.—In this Manner the Earth measures the Length of her annual Orbit, or solar tropical Year; the Period of a Luration, or the Time while the Moon is going from one Opposition or Conjunction of the Sun, to her next Opposition or Conjunction.—The Length of a Lunar Year, or twelve Lunations.—The Length of the Orbits of the Planets, Comets, &c.—And also the Times when the Eclipses are to happen, or that particular Time, when the Moon crosses the Earth's annual Orbit, either in Conjunction
with

with the Sun, and in a direct Line between the Earth and the Sun; or in Opposition, when the Earth is in a direct Line between the Sun and Moon.—The Moon does not measure her own Orbit, but, points out the Seasons, by Her Intersections of the annual Orbit of the Earth.

Let us now examine whether the annual Path of the Earth is equally divided, by the twelve Signs, or not.—She goes from *Libra* to *Aries*, or the six Winter Signs, or Winter Half, in 178 D. 17 H. 58 M. But the Summer Half, or six Signs, viz. from the Vernal to the autumnal Equinox, require 186 D. 11 H. 51 M. to compleat it; which shews us She is more than a Week longer in traversing the Summer six Signs, than She is in traversing the Winter six Signs.—From whence it may be observed, that She increases her Distance from the Sun, greatly, after She has passed the vernal Equinox, and that She must be many thousands of Miles farther from the Sun, at the Summer Solstice, than She is at the Winter Solstice.—She is also
31 D.

“ 5 H. 49 M. but *at present* a few Seconds
“ shorter, and has been continually decreas-
“ ing, somewhat unequally, for some Years
“ past, and in all Probability will continue
“ to diminish for some Ages to come.” —
This appears to be an Assertion without Evi-
dence to support it.—It is true, that different
Astronomers, by their Observations, have
made the annual Orbit of different Lengths,
hardly any two agreeing about what is the
Length of it, except those who have made it
365 D. 5 H. 49 M.—The Length of it,
according to Sir *Isaac Newton*, is 365 D. 5 H.
48 M. 57 S.—Hence is *partly* the Reason
why the ancient Eclipses, of more than two
thousand Years standing, cannot be calculated
by the present Tables, which come short of
them.—This Error, has been attributed, to
the Moon’s being nearer the Earth now than
She was then ; but, in Fact, the Cause does
not arise from this, but from the erroneous
tabular Measure.

The measuring the annual Orbit of the
Earth, by two Observations, only *one* Year
between

between is so precarious, that almost every Astronomer will make a different Observation this Year from that he does the next; hence it may be observed, that different Astronomers will not only vary from one another, but also the same Astronomer will differ from Himself.—Dr. Keil tells us, ^(h) that “ by
 “ Observations that are made at the Distance
 “ of one Year, we *cannot safely* rely upon the
 “ Quantity of the Year collected from them;
 “ for a small Error of one Minute, being
 “ constantly increased, and multiplied by
 “ the Number of Years, in Process of Time,
 “ would amount to a prodigious Mistake in
 “ the Place of the Sun, therefore the Astron-
 “ omers more accurately determine the Quan-
 “ tity of the Year, by taking the Observati-
 “ ons of two Equinoxes, at *many* Years Dis-
 “ tance from one another; and dividing the
 “ Time, by the Number of Revolutions the
 “ Sun has made, the Quantity will shew the
 “ Time of one Revolution, or *nearly* the
 “ Period of the Earth in her Orbit.—For,
 “ by

(h) Lect. 22. P. 271.

“ by this Means, if there be any Mistake
“ made in the Observation, it will be divid-
“ ed into so many Parts, according to the
“ Number of Years, that it will be insensible
“ for the Space of one Year.”

Dr. Keil, as above, having remarked the great Difficulty there is, in observing when the Sun is in the Plane of the Meridian; of the Place of Observation; and also the Uncertainty of it was such, that he calls the Error of a *Minute* a *small Error*; and, therefore, in order to come *near* the Truth, we are to take the Observations of two Equinoxes, at many Years Distance from one another, and dividing the Time by the Number of Revolutions the Sun has made, the Quantity will shew the Time of one Revolution *nearly*.

Now in Order to find the Length of the tropical Year, Mr. Kennedy took Dr. Keil's Direction, and tried it by the Observations of two remarkable great and exact Astronomers, which were made 168 Years Distance from each other,—The first Observation was made
by

24 *The INTRODUCTION.*

by *Tycho Brake*, at *Uraniberg*, A. D. 1585, and the last by *Dr. Bradley*, at *Greenwich*, 1753. By this he found the Length of the solar tropical Year to be exactly 365 D. 5 H. 49 M. ⁽ⁱ⁾ From which may be deduced, that 365 D. 5 H. 49 M. is the exact Length of the solar tropical Year, and also, that it is no shorter now than it was 168 Years ago. ^(k)

A natural Day, or one Rotation of the Equator, contains 24 Hours in Time, or 1440 Minutes; these may be called equato-real Minutes, as there are Terminations, in Measure, on the Equator, which answer to every one of them.—The Equator precedes forward 11 of these Minutes, every solar Year; and in 1440 Years, it passes through all its meridional Variations, and at the End of that Period, it returns again to the original Point of the Day, in the same Place or Meridian, where it began, but not on the same Day of the Week.—As this is an exact Cycle

(i) Kennedy, P. 159.— (k) Introduction, Page 23.

cle of the Sun, so all the Multiples of this Number will be so too, as 2880, 3420, 5760, &c. will compleat solar Cycles; therefore if you know the Time when the Sun enters *Libra*, or any other Point in the Heavens, on any one of the Years of any Cycle; by that you will also know the Time when the Sun enters *Libra*, the same Year, in all other Cycles. (1)

The fourth Cycle ended A. D. 1783.—Here we have 5760 Revolutions to try the exact Length of the solar tropical Year by; and throughout all this Period of Time, the Sun will be found to enter *Libra* at the Times calculated, according to the Length of the solar Year being exactly 365 D. 5 H. 49 M. Thus let the autumnal Equinox 706, of the Julian Period, be one Point, and the autumnal Equinox, 6466 of the same Period, be the other Point.—Between these two Points, the Earth has made 5760 Revolutions; and by an accurate Observation that Dr. Bradley made that Year, A. D. 1753, at Greenwich,
D. which

(1) See Letter, No. 8, 10.

which was the Year in Connection with 6466, of the Julian Period, the Sun was observed to enter Libra at the Day, Hour, and Minute it did 5760 Years before, and Calculations, according to this Length of the Year, will be found to agree with the Observations made every Year throughout this Period, and also all succeeding ones. ^(m) Is not this Demonstration, that this Length of the Year is perfectly right?

In Order to understand some Parts of these Letters the better, I shall give a Description of the patriarchal or israelitish Year, according to the Calendar of it, as it is found in the Scriptures, or as it was observed by the ancient Israelites.

It appears clear, that the Seasons in which Moses ordered the Feasts to be kept, and the Directions which he gave to the Israelites for keeping them, were pointed out by a well known and simple Calendar; which, at that
Time,

(m) See Letter, No. 6.

Time, may be supposed to be understood by all; therefore, there was no Occasion to describe it.—This Calendar seems to be formed in a most simple, clear, and exact Manner. They calculated their Months *astronomically*, by the Number of Rotations made by the Earth, (in Appearance) as mechanically as a Clock points out the Hours of the Day.—They did not seem to have any Regard to the Motions of the heavenly Bodies, any more than if they had no Motion at all.—Thus, we may remark, that the Patriarchs, instead of being left to find out, by Observations on the Heavenly Bodies, the Length of the Years, whereby their Festivals and Seasons were to be calculated and observed, they were instructed by a Calendar of *integral Days*, and Quadrants, to calculate astronomically the Times appointed for keeping of them, and thereby to record the Ages of the Patriarchs, and therewith the Age of the World; this they were to do by the solar tropical Year, but to record Events by Days and Months of the lunar.—Indeed had not Moses, at the Time he ordered them to keep these Festivals
at

at their particular Seasons, given them Directions how to know when these Seasons came, it would be very absurd to expect it from them.—But he instructed them to measure both the solar and lunar Year, by a certain Number of the Rotations of the Earth, or natural Days.—In this Manner the Patriarchs and the Israelites always expressed their Ages, viz. by *Days of Years*, to shew that their Years were measured by Days.—Thus when *Pharoah* asked *Jacob* how old he was.

(u) In the English Text it is, “ *And Pharoah said unto Jacob, how old art thou.*”—In the Margin, you have a literal Translation of the Hebrew.—“ *How many are the Days of the Years of thy Life;*” *Jacob* answered him in the same Stile—“ *The Days of my Years, &c.*

Thus it may be infered, that their annual Calendars contained a certain Number of Days, and that their Years were measured by those Days.

They began to count the Beginning of
their

(u) Gen. XLVII. 8, 9.

their Days, at Six o'Clock in the Evening, (o) at the going down of the Sun, (which it always did in the Latitude where Paradise is supposed to be placed, and, nearly so, in Egypt and the Wilderneys.)—Thus, as soon as the Sun was out of Sight, they added that Day to the former Number; and the next Day immediately began.—Six Days of the Week they were to work, which sixth Day ended at the going down of the Sun that same Evening, when the seventh or Sabbath began; and at the going down of the Sun, the Evening of the Sabbath, their Week, or Cycle of seven Days ended, and the first Day of the next Week began; and, in Order to keep and to commemorate their Sabbath, they had a holy Convocation thereon, which was their first and principal Festival.

Their Day was divided into four Quadrants or Quarters, and had four cardinal Points; the first began at Six o'Clock in the Evening, and ended at Mid-night; the second ended at Six in the Morning; the third at Mid-day, and

(o) Levit. XXIII. 32.

and the fourth at Six in the Evening; when the next Day began.—This is the Method which Moses ordered Time to be measured and recorded by, and the Method that the Sun and Moon do it, viz. by the Number of the Earth's Rotations.

Thus, notwithstanding in Appearance they measured mechanically by Calendar Numbers only, yet at certain Times, these Numbers met the Motions of the Heavenly Bodies, and their Calculations turned out astronomically true.—They made Use of two Years to measure and record Times and Seasons by; the one by the apparent Motions of the Sun, (or more properly the Motions of the Earth,) and the other by Lunations or the Revolutions of the Moon; which two Years, being measured by Days *only*, prevented the Times appointed, at particular Seasons of the Year, from ever altering; and to prevent their forgetting or mistaking the appointed Seasons, when these Transactions began and ended; Moses ordered Festivals and holy Convocations to be kept at these appointed Times, to commemorate them.

Their lunar Year consisted of $354\frac{1}{4}$ Days; and was divided into twelve Months; the first Month of the Year began at the new Moon before the Feast of Tabernacles. The first Day of the Feast of Tabernacles, or the Ingathering of the Fruits of the Earth, was appointed to commemorate the Place of the Sun and Moon at the Creation, and was always to be celebrated on the 15th Day of this Month, or (as expressed in the Hebrew) the Moon; which was at its first Appearance, on the going down of the Sun, after the full, in Commemoration that that was the Place of the Moon, on the fourth Evening of the Creation; as the autumnal Equinox was the Point where the Sun was first placed, at that Time.* As has been already observed, they began

* As this was the first Day that the Chronology of the World commenced, the Israelites, (which is still continued amongst the Jews to this Day,) “on their Return from the Synagogue, salute each other with saying, “to a good Year shall you be writ, for according to Tradition, this is the “Day that God created the World, so it is that on which God judges it; “and therefore (says David Levi) (p) in our Prayers, on this Festival; we “pray to God, to renew unto us a good Year.”—As Trumpets were always made use of on the first Day of this Feast, so it was called the Feast of Trumpets, a Memorial of blowing of Trumpets. (q) David Levi tells us, (r) “that their Trumpets are always made of a Ram’s Horn, in Re-

(p) P. 75.—(q) Levit. XXIII. 24.—(r) P. 79.

began their Days at Six o'Clock in the Evening; their lunar Year began at the same Point, and consisted of $354\frac{1}{4}$ Days; so the first lunar Year began, at the same cardinal Point with the Day, and it ended at the cardinal Point of the next Quadrant, viz. at Mid-night; the second ended at Six in the Morning; the third at Noon, and the fourth at Six in the Evening; at which Point of the Day, the lunar Year was compleated and ended; and was then added to the End of the fourth Year, which contained 355 Days, whereas, the first three of this Cycle of four Years, contained only 354.

This lunar Year was divided into twelve Months, and was calculated by the Patriarchs, and ancient Israelites, by Calendar Numbers only, and continued to be so till after the
 Captivity

“membrance of Abraham offering his Son Isaac, when the Angel of the
 “Lord called to him out of Heaven, and said, lay not thine Hand upon
 “the Lad—and Abraham seeing a Ram, caught by the Horns, in a
 “Thicket, he went and offered Him up for a Burnt Offering, instead of
 “his Son; our Traditions inform us, that happened on this Day, (s) we
 “therefore make Use of a Trumpet, made of Ram's Horn, as a Memorial
 “of it.”

(s) Gen. XXII. 8. 9.

Captivity of the Jews, when they learned and introduced a different Method of pointing out, and of calculating this lunar Months. It is supposed they learned their Method during their Captivity amongst the Babylonians and Greeks; from that Time, to this Day, they calculate their Months by the Appearance of the Moon, next after the Change, and by 29 and 30 Days, according as it appeared; but they never made their Months to contain more than thirty Days. But, according to the Calendar Numbers of the Israelites, their first eleven Months contained 30 Days each, and their twelfth 24 Days only; and at the End of their Cycle of four Years, 25 Days.—At this Point, their Calendar Numbers met the Lunations astronomically.

The first Day of every lunar Month was called the Month or Moon-day; on this Day they had a Festival, and holy Convocation, as a Memorial that the last Month was ended, and another began.—By these lunar

E

Months

Months, all Events and Transactions were recorded.

The solar Year, (by which the Ages of the Patriarchs were recorded, whose Ages were always made to begin and end at the autumnal Equinox, and thereby to run parallel with the Years of the World,) contained $365\frac{1}{4}$ Days; but then this Quadrant at the End of the Year, like the Lunar, did not come into the Reckoning till at the End of the Quadriennium, or Cycle of four Years, was compleated; so that the first three Years of the Quadriennium consisted of 365 Days each, and the fourth of 366.—The solar Day began at Noon, as it did on the fourth Day of the Creation, therefore it anticipates the lunar one Quadrant of a Day, as that did not begin till Six in the Evening.—Thus, as this Quadrant reached from Noon to Sun-setting, so it shews us that the first Year of the World must be reckoned as the second of the Quadriennium; therefore, when we would know the Quadriennium of the World's Age,

Age, we must add 1 to A. M. and then divide by 4—this will always give you the Quadriennium sought.—The solar Day was divided into Quadrants, as the lunar, at the four cardinal Points.

Hence, it may be observed, that the lunar Year consisted of $354\frac{1}{4}$ Days, and the solar $365\frac{1}{4}$.—If we subtract the lunar from the solar, it leaves 11 Days, (the Difference in Length between the two Years;) which is called the *Epaēt*, and is a great Means to distinguish one Year from another.

As the two Years were carried on together, and both measured by integral Days; so they regulated each other in the following Manner; the first solar Year was one Quadrant and eleven Days longer than the lunar; this odd Quadrant was occasioned by the solar Time beginning so long before the lunar.—The two first solar Years contained $730\frac{3}{4}$ Days, while the two lunar contained only $708\frac{1}{2}$, so that the *Epaēt*, at the End of this Year,

Year, was $22\frac{1}{4}$ Days, the lunar Year being so far short of the solar.—The first Day of the Month, of the lunar Year, was on the first Appearance of the Moon, after the Conjunction, which was nearest to the autumnal Equinox, and came before it: Now, as the Moon was 15 Days old, or passed its Full, on the first Year of the Creation, so if we subtract 15 from 22, it will leave 7 for the Epact; and so much the new Moon Year will precede the Solar.—The next lunar Year, added to these two, will make 1096 Days, while the three lunar contain $1062\frac{3}{4}$ Days only, which are $33\frac{1}{4}$ short of the solar.—Now as the twelfth lunar Month contained no more than 24 Days, so it over-ran the full Moon 9 Days; therefore as the first Day of the Feast of Ingathering was to be on the full Moon which happened either upon the autumnal Equinox, or the next which followed, they added a Month of 30 Days, and the next new Moon, lunar Year, began 6 Days after the solar Year ended. The Number of Days contained in the solar Quadriennium,

driennium, are 1461, while the lunar have but 1417; to which add the Month of 30 Days, and it makes 1447; which substract from 1461; the Days of the solar, leave 14, and so many Days the full Moon, lunar Year, precede the next solar.

Hence it may be observed, that both Years are measured by integral Days, and that the annexed Quadrant was not reckoned till the Day was compleated, which it always was at the End of every four Years.—At first View, this annexed Quadrant, at the End of each Year, has the Appearance as if it would cause a Confusion between them; but the contrary is found to be the Fact; for it may be observed, that the Quadrant, annexed to both Years, rectify each other in so exact a Manner, that it appears to be appointed by God himself, as the Medium or Bond of Connection between them.

From what has been said, it may be remarked, that take any four Years of the
World,

38 *The INTRODUCTION.*

World, the lunar Computation is not only included in the solar, but is equal to it.

For first, every four solar Years in Succession, include first four lunar Years, three of which consist of 354, and one of 355 Days, whose Sum is 1417. Secondly. They include four lunar Epacts, three of which consist of 11 Days, and one of 10 Days, whose Sum is 43 Days, which being added to 1417, make 1460. Thirdly. They include four Quadrants, which make one Day; to 1460 add that one Day, and the whole Amount of lunar Days will be 1461, the same as the Solar.

The solar Year, like the Lunar, was divided into twelve Calendar Months;—the first eleven contained the same Number of Days that the Lunar did, viz. of 30 Days each; but the twelfth had 35 Days.—These twelve solar Months began and ended at the same Point of Time with the twelve Signs—they began when the Sun entered Libra, till
after

after the Exodus of the Israelites out of Egypt, when they altered the Beginning of the Year by God's express Command, from the autumnal Equinox, to the Vernal; their first Month was altered to the seventh, and their seventh to the first; (t) their Sabbath was altered from the seventh Day to the sixth. — The Israelites counted these Months by Calendar Numbers, in the same Manner they did their lunar Months, but at the End of every Quadriennium they met the Sun *Astronomically*, at the same Point of the Day, in the same Sign.

The Use which the Israelites made of the Months of the solar tropical Year, was for the coming in and going out of the twelve Courses of Military Officers, and of the 24 Courses of Priests, (u) who waited in the Temple; these Priests went in and came out every Sabbath Day; so that it came to the Turn of each Priest (v) to wait two Courses in the Year, besides the three Festivals; when
all

(t) Exod. XII. 1.

(u) 1 Chron. XXIV. 7. — XXVII. 1. — (v) 2. Kings, XI. 5, 7.

all the Courses waited. ^(w) They began their Year at the Feast of the Passover, which lasted till the Morrow after the Sabbath, when the wave Sheaf was offered, after which they began to count the seven Weeks, between that and Pentecost, or the Feast of Weeks; the third Feast was the Feast of Tabernacles, or Ingathering, which lasted eight Days. These Feasts made four Weeks, when all the Courses waited; and the 24 Courses twice over, made 48 Weeks; which, with the four Weeks of the Festivals, make in the Whole 52 Weeks, with one Day for all the Courses to go out and come in, will compleat the solar tropical Year, which contains 52 Weeks and one Day.

After the Exodus of the Israelites, from their Bondage out of Egypt, they kept their Feast of Tabernacles and Ingathering, according to Moses's Directions, as do the Jews to this Day, ^(x) *on the fifteenth Day of the seventh Month, (from the vernal Equinox)*
when

(w) 2 Chron. V. 11. — (x) Levit. XXIII. 39.

pened.—In order to do this, let us examine the Scriptures, and try what Assistance may be received from them, for when they are examined carefully, and with a good Intention, we often find that they contain more than we expected to find in them.—It is generally agreed, that the Ceremonies and Works of the Law were typical of those Things which were fulfilled in the Gospel ; both Testaments being a Counter-part to each other, as our Saviour told the Jews ; *search the Scriptures, for in them ye think ye have eternal Life ; they are which testify of me. If ye had believed Moses, ye would have believed me : for he wrote of me.* (z) That the Temple typified the Body of Christ we are certain, for our Saviour himself told us so. (aa) The Feast of Dedication of Solomon's Temple, was kept on the Feast of Tabernacles, (bb) in the seventh Month,—and on the eighth Day they made a solemn Assembly for its Dedication. If this was a Type of Christ, there

(z) John V. 39. 46,—(aa) John II. 19. 21.—(bb) II. Chron. V. 3. 7. 8.

there is no Doubt but that it was fulfilled by its Antitype.

St. Luke tells us, (cc) *That in the Days of Herod the King, of Judea, that a certain Priest named Zacharias, of the Course of Abia. And it came to pass, that as soon as the Days of his Ministration were accomplished, that he departed to his own House; and that after those Days, his Wife Elizabeth, conceived and hid herself five Months— And in the sixth Month, the Angel Gabriel was sent from God, to a Virgin, and said unto her— behold thy Cousin Elizabeth, she has also conceived a Son in her old Age, and this is the sixth Month with her.*

In order to know the Season of the Year when this happened, St. Luke tells us, that it was directly after *Zacharias's* Days of Ministration were accomplished—And that *Zacharias* was of the Course of *Abia*.—And in *Chronicles* (dd) we are informed that *Abia* belonged

(cc) Luke I. 1. 23, &c.—(dd) I. Chron. XXIV. 16.

44 *The INTRODUCTION.*

longed to the eighth Course. — Now the Priests began these Courses of Ministration after the Sabbath (which followed the Passover) was over.—During the Feast of the Passover, or Feast of Unleavened Bread, (which was seven Days,) all the Courses of the Priests ministered together.—That the Beginning of the fifty Days, between the Feast of the Passover, and the Feast of Weeks, was to commence on the Morrow after the Sabbath, when the wave Sheaf was offered (cc) so that the first Course were to begin their Ministration on the second Sabbath after the Passover, which was (ff) *Jehajorib*; the second *Jedaiah*; the third *Horim*; the fourth *Searim*; the fifth *Milchijah*; the sixth *Mijamin*; the seventh *Habbez*—the next Week came the Feast of Weeks or Pentecost.—Hence the Course of *Abiah*, (which was the eighth) did not come in till the Week after Pentecost.—Now if we count the Weeks they will be, the Passover two Weeks, between that Feast and Pentecost seven Weeks,
Pentecost

(cc) Levit. XXIII. 15.—(ff) I. Chron. XXIV. 7 to 10.

Pentecost one Week, and *Abias*, the Week after, one Week; in all eleven Weeks.—So that the Week after his Ministration must be the twelfth after the Passover Day.—Subtract 12 from 52, the Number of Weeks in a solar tropical Year; and there will remain 40 Weeks, the exact Time of Gestation, to which add one Day for the Day of the Birth, and that will bring it to the Passover Day, when John Baptist was born.—Add to this six Months, (the Difference between the Conception of Elizabeth, and when the Angel Gabriel was sent to the Virgin) and it will bring it to the 15th of the seventh Month, when Christ was born.

Now multiply the 40 Weeks by 7, and the Product will be 280; add 1 for the Day of the Birth, and it will make 281 Days, (as these are lunar Months) subtract 266 Days for the nine Months of Gestation, and the Remainder 15 will express the true astronomical Day when the Baptist and Messiah were born.—John the Baptist was born on
the

46 *The* INTRODUCTION.

the 15th of the first Month, or Passover Day, and the Messiah on the 15th of the seventh Month, when the Feast of Tabernacles commenced.

The vulgar Era of Christ's Birth was not settled till A. D. 527, when it was done by Dionisius, a Roman Abbot, since which it has been generally received and followed by Christians.—Had this Era began in the Time of the Apostles, there is no Doubt but it had been right, but as it did not become an Era till the sixth Century, it is not at all to be wondered at, if it should be found to be not exactly right, as it certainly is not.—As there is no Certainty in Chronology, without it is confirmed by Astronomy, I shall endeavour to settle it according thereto.

We are told in the Gospel ^(gg) that Christ was born while Herod was King of Judea ; who sought to kill Him, as soon as he heard of his Birth ; but *Joseph*, being warned of God,

(gg) Matthew II. 16.

The INTRODUCTION. 47

God, fled into Egypt with him, where he remained till he heard of Herod's Death, which happened in the Year 4711 of the Julian Period; but the vulgar Era, settled by Dionisius, makes his Birth to have happened in the Year 4713 of that Era.

Josephus informs us ^(hh) that Herod died in the 26th Year of Augustus Cæsar, and a little before the Passover, and that there was an Eclipse of the Moon during his last Illness.—Now, if we calculate that Eclipse of the Moon, it must settle astronomically the Year when Herod died.

This Eclipse is not to be found amongst the Catalogue of Eclipses, but Mr. Ferguson ⁽ⁱⁱ⁾ says, “It appears by our Astronomical
“Tables to have been in the Year of the Julian Period, 4710, March 13th, at 3
“Hours past Mid-night, at Jerusalem.”—

At the End of this Introduction ^(kk) I shall
add

^(hh) *Josephus* lib. XVII. Cap. 8 and 11. — ⁽ⁱⁱ⁾ Ferguson, P. 385, S. 395.

^(kk) Page

add a Calculation of this Eclipse, by which it will appear, that Mr. Ferguson has made a Mistake of one Year in his Calculation, for you may observe, from my Calculation, that this Eclipse must have happened A I P 4711, and not 4710, and that it happened according to Mr. Ferguson's Time, March 13, N. S. 3 H. 40 M. 33 S. It could not be on the 13th of March, 4710, because the Full Moon, in that Year, happened on the 23d Day of March, instead of the 13th, when the Moon's Node was too far Distant, at that Time, from the Sun, to cause an Eclipse.

As it may be observed from these Calculations, that our Saviour was born on the first Day of the Feast of Tabernacles, in the 26th of Augustus Cæsar, on a Sunday, the seventh Day of the Week from the Creation, in the Year of the World, (according to the Mosaic Chronology) 4005, about five Months before Herod died, which *Josephus* tells us was a little before the Passover Day, or the 14th of Nisan, which happened that Year on April

11, of the Julian Calendar.—This corrects the vulgar Era, two Years and 89 Days: It was then proposed to bring the Beginning of the Year, from the autumnal Equinox, (nearly the Place it had got by irregular Inter-calations,) back to the Calends of January.

Soon after the Feast of Tabernacles, when Christ was born, and Herod sought his Death by ordering all the young Children in Bethlehem, of two Years old and under, to be slain; Joseph carried him into Egypt, where he remained till after Herod's Death, which happened about five Months after.

As the Reader may be desirous to know the Reason why Christians kept the Festival of Christ's Birth, at the Winter Solstice, instead of the Autumnal Equinox, which appears to be the true Season; and, as History is silent hereon, I shall give the most probable Account I can concerning it.—In order to do this, it appears proper to examine the Method of recording Events at that Time.

G

IN

In the first Place, it must be observed, that the Romans were Masters of the then known World, and that they obliged all the conquered People to obey their Laws.

Forty-six Years before the vulgar Era, Julius Cæsar, finding great Inconveniencies to proceed from the Irregularity of the Roman Calendar then in Use, which was of a lunar Year, and required an Intercalation every Year to make it agree with the Solar; and that by the bad Management of the *Pontifices*, who had the ordering of it, the Calends of January were got from the Winter Solstice, (to which they had been placed by Numa, about 560 Years before,) nearly to the autumnal Equinox; he therefore, to make a more perfect Calendar of the Year, called to his Assistance an Astronomer from Alexandria; who, in order to put the Seasons into their right Places, very carefully observed the Sun's Place in the Ecliptic; and by reckoning the greater Part of October, November, and December, twice over, he effected it.—Thus, when by the old Calendar,

dar, the Year was got to the Calends of January, he brought it back and began it again nearly to the autumnal Equinox; by this Means, the Winter Solstice of the new Calendar, (as *Ovid* informs us,)* was made the Point where the old Year ended, and where the new one began.

Other Roman Writers also inform us the same; but *Pliny* and *Columella* tell us, that the Calends of January, with the other Equinox, and the Solstices, were placed in the 8th Degree of each Sign, and were much perplexed to account for it; but the Fact appears to be, that the Alexandrian Astronomer, finding that the Equinoxes had preceded the Calendar Measure, he ordered the Beginning of the political Year to be placed in the 8th Degree of *Capricorn*, instead of the first, thinking thereby to place the Calendar Computation where it might agree with the Solar.

About ten Years before our Saviour was
born,

* *Bruma novi prima est veterisque Novissimus Anni,
Principium capiunt Phœbus et Annus idem.* OVID.

born, they found that an Error had been committed, by adding the Day of the Leap Year to every third Year, instead of every fourth, whereby three supernumerary Days had got into the Calendar ; but by *August Cæsar's* ordering that no Leap Year should be again put into the Calendar for the twelve Years next ensuing, brought it right again ; and then imagined that the Calendar would never more want any farther Correction.—This was believed so late as the Council of Nice, which was held, according to vulgar Era, A. D. 325. For by their paschal Canons, they erroneously fixed the 21st of March for the Sun's Entry into the Equinoctial Point, and took it for granted, that it would be immoveably fixed to that Day of the Julian Calendar.—For it does not appear that Astronomers were capable of observing the exact Time of the Sun's entering the Equinoctial Points, till *Tycho Brahe*, by his Improvements in Astronomy, did it.—After this Reformation by Julius and Augustus Cæsar, to prevent Confusion by different Calendars, *Strauchas* informs us, ⁽¹¹⁾ that severe Laws were made to punish

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(11) Book XV. Chap. 43, (Salt's Translation.)

any People who did not conform thereto, or who made Use of any other.

Now the above was the State of Calendar Computation at the Coming of Christ.—All the Roman Empire knowing what Pains Julius Cæsar had taken to set all the Seasons in their true Places, and to make a true Calendar of the Year, it would have been strange, and have the Appearance of great Obstinacy, for any one to have acted in Contradiction to it; and therefore, the Christians, no doubt, did conform to it, and made Use of it; for, it was one of the Principles of Christianity, taught by St. Peter himself, ^(mm) “to submit
“themselves to every Ordinance of Man for
“the Lord’s Sake, whether it be to the
“King as Supreme, or unto his Governors.”

Thus it may be observed in what a State of Confusion the Calendar Computation had been in, about the Birth of Christ; and what Pains had been taken, by the Roman Emperors, to set it upon a right Foundation.—
He

^(mm) I. Peter, II. 13.

54 *The* INTRODUCTION.

He was born amongst the Jews, who, with the Patriarchs and Israelites, from the very Beginning to this Time, have always believed, that the Creation happened at the Full Moon nearest after the Autumnal Equinox, and that the Feast of Ingathering was appointed by God, and ordered by Moses to be kept in Commemoration of it.—The Feast of Tabernacles was ordered to be kept at the same Time; but as that was to be a Memorial of their Deliverance from the Egyptian Bondage, when they dwelled in Tabernacles, so they were ordered to dress their Habitations with green Boughs, to commemorate it; (nn) Christ being born amongst the Jews, on *the first Day of this Feast*, the Christians dressed their Houses also with green Boughs, for a Memorial that Christ was born on that Day.

Now as Christ was born on *New Year's Day*, and as St. Paul tells us (oo) that in his Time, “there were many unruly and vain
“Talkers and Deceivers, especially they of
“the

(nn) See P. 41.—(oo) Titus, I. 10.

“ the Circumcision,” (soon after which the Circumcision and Uncircumcision separated themselves from each other); it would have been astonishing had the Christians observed their Seasons by any other Calendar than that which Julius Cæsar and Augustus had taken so much Pains to make compleat: But though they kept the Festival in Commemoration of the Birth of Christ, on *New Year’s Day*, according to the Julian Computation, yet still they continued their Custom of dressing their Habitations with green Boughs, to show that it was on the Feast of Tabernacles that He was born.—It may be observed, that they also settled every other Feast and Festival according to the Julian Calendar.—The Names of the twelve Signs begin in the Latin Language, it appears probable they were given to them at this Time.—For though they are the same with the solar Months of the Israelites, yet the Knowledge and Use of them were almost lost.—It does not appear that any People besides the Jews and Greeks made Use of the solar Year, all others had the lunar, with Intercalations; this was *Numa’s* Year.

For

For the Reasons before-mentioned, Julius Cæsar, with the Assistance of an Alexandrian Astronomer, altered it to the solar; and they then believed they had settled the Calendar in so exact a Manner, that the Seasons would always thereafter be kept to their true Places. The Israelites distinguished their solar Months, as well as their lunar, by Numerals; but, it seems, (as Julius Cæsar was not willing to make so great an Alteration in all the civil Months, as to make them to tally exactly with the Signs in the Heavens,) that the Astronomer gave Names to the Signs, expressive of the Season of the Year which they pointed out.

Thus *Aries*, the *Ram*, the Point when the Sun enters the Vernal Equinox, was represented by a Ram, the Horns of Animals being always made Use of to shew the Strength of the Sun; so the Ram, the Head of the Flock, was a proper Emblem to exhibit to us, by his *Horns*, the increasing Strength of the Sun's Heat.

The

bout July 21.—Notwithstanding the Astronomer did not alter the civil Months, to begin and end according to the Signs in the Heavens, yet he named one of these Months, which answered nearly to this Sign, *Julius*, in Honour to his Patron *Julius Cæsar*, letting us know, that as the Heat of the Sun was then at the greatest, so it commemorated the greatest Emperor of the World.

The 6th Sign was *Virgo*, represented by a young Woman, into which the Sun enters about the 22d of August: a young Woman grown to Puberty, is the Instrument by which the Increase of the Human Species is brought forth! during this Sign, the Trees and Vegetables produce their Fruit and Seed.—Hence, the Astronomer thought it proper to exhibit the Reign of Augustus Cæsar; in whose Time Peace and Plenty reigned, and Arts and Sciences flourished.

The 7th is *Libra*, into which the Sun enters about Sept. 22d, where one Year ends, and another begins! Here also the Twin-
Brothers,

The INTRODUCTION. 59

Brothers, *Heat* and *Cold*, ballance each other ; what can more properly represent these than a Pair of Scales ?

The 8th Sign is *Scorpio*, a Scorpion ; a destructive Animal ! who does its Mischief by his hinder Part or Tail ; representing to us the Injury done by the *cold Ether* following the departing Heat.—The Sun enters this Sign about Oct. 22, and on Nov. 21 comes

The 9th, *Sagittarius*, the Shooter, to exhibit to us the great Power of the *cold Ether*, during this Sign ; which greatly hurts, kills, or destroys a large Part of the Productions of Nature ; whose Arrows are so subtile and piercing as to enter the Pores of all Matter.

The 10th Sign is *Capricornus*, a horned Goat ; an Animal who gets his living by climbing Hills and Precipices ! A very proper Emblem to represent the rising Strength
of

60 *The* *INTRODUCTION.*

of the Sun ! which it begins to do about the 21st of December, when the Sun enters this Sign.

The 11th is *Aquarius*, represented by flowing Water, to denote this watery Season.

The 12th and last is *Pisces*, Fishes ; the most prolific of all Animals ! representing to us the approaching Fertility of the Season ; when Seeds and Plants are made to vegetate by the growing Power of the Sun.

From the above Account of the Signs, it may be remarked, that *Heat* and *Cold* were then believed to be the Agents which governed the *Mechanism* of Nature.—In this they agreed with the ancient Philosophers ; for *Plato* tells us, “ that they maintained “ that *Fire* and *Heat* govern all other Things,” and “ that *Fire* expands all Bodies outward, “ and that *Air* compresses them together inward, and counteracts the *internal Fire* : By “ the *Ministry* of these Causes a perpetual Circulation is kept up.” These, (says he), “ are

“ are *secondary and co-operating* Causes, which
 “ *God* makes use of as his Ministers.” And
 Cicero, in describing the Tenets of the an-
 cient *Platonists*, does it in the following
 Words. —“ *De Naturâ* autem ita dicebant,
 “ ut eam dividerent in *Res duas*: ut altera
 “ esset efficiens, altera autem, quasi *huic se*
 “ *prebens*. — Neque enim Materiam ipsam
 “ cohærere potuisse, si nulla vi contineretur:
 “ neque vim sine aliquâ *Materiâ*. — Illa Jnitia
 “ Elementa dicuntur, e quibus *Aer & Ignis*
 “ movendi vim habent & efficiendi, reliquæ
 “ Portes accipiendi & quasi patiendi, *Aquam*
 “ dico & *Terram*.” *Acad Quæst.* lib. 1, or
 in English thus. —“ That they divided Na-
 “ ture into two Parts, one of which was
 “ *active*, and the other *passive*. — They held
 “ it impossible for Bodies to *cohere*, unless
 “ they were kept together by some Force;
 “ and that it was necessary this Force should
 “ be exerted by *some Matter*. — In distinguish-
 “ ing the several Uses of the Elements, they
 “ attributed to *Air* and *Fire*, the Power of
 “ giving Motion, and *causing* Effects; to
 “ *Earth*

62 *The INTRODUCTION.*

“*Earth and Water a Passiveness, or Disposition to receive their Impressions.*”

Hence we are taught the Doctrine of ancient Philosophers ; which they received, by Tradition, from their Ancestors, and from their Observations on the *Phænomena* of Nature.—Perhaps if we divest ourselves of the Prejudices imbibed by our Education, we shall find it to be true.—It is probable, that these Philosophers received their Traditions from Noah and the Patriarchs, as it appears to be the same taught by Moses, who informs us, (pp) that God created the Heavens and the Earth ; “ that the *Heavens and Skies* “ were in continual *Conflict, Motion, and* “ *Expansion* ; to which he gave the Name of “ the *Placers, the Disposers, or Governors,* “ *under God, of all Nature.*”—We are told in Samuel, (qq) that the Vegetable is *pushed out of the Earth by a shining Light and by Rain* ; and in the 19th Psalm we are informed, *that the Mechanical Circulations of the Heavens represent the Glory of God ; and the*
Firmament

(pp) Gen. I. Chap. 1.—(qq) II. Samuel, XXIII. 4.

Firmament (Expansion) his handy Work; and that their Fulness and Influence reach unto the End of the World.—That in them he has placed the Tabernacle of the Sun's Light, which coming out like a strong Man, prevails to the Extremities of them, and nothing is hid from the Heat thereof. To return from this Digression,

In regard to the Death of Christ, it is agreed, that he died on a Friday, the Full Moon Day, on the 14th of Nisan.—Hence it is no difficult Matter, to calculate the Year when this happened; as, two Passover Days could not happen on a Friday for many Years following.

The Time of this Passover, or the Death of the Messiah, was foretold by the Prophet Daniel, 562 Years before. (rr) In the first Year of the Reign of *Darius I.* Daniel prophesied, (ss) “That seventy Weeks (of Years) “are determined upon thy People, and upon “thy holy City, to finish Transgressions, “and to make an End of Sin, and to make
“Reconciliation

(rr) Daniel, IX. 1.—(ss) Daniel, IX. 24, 25, 26, 27.

64 *The INTRODUCTION.*

“ Reconciliation for Iniquity, and to bring
 “ in everlasting Righteousness, and to seal
 “ up the Vision and Prophecy.— Know
 “ therefore that from the going forth of the
 “ Commandment, to restore and build Je-
 “ rusalem, unto Messiah the Prince, shall be
 seven Weeks ; and three-score and two Weeks
 “ the Street shall be built again.—And after
 “ three-score and two Weeks, shall Messiah
 “ be cut off, but not for Himself.—And the
 “ People of the Prince that shall come, shall
 “ destroy the City and the Sanctuary, and he
 “ shall confirm the Covenant with many for
 “ one Week ; and in the *midst* of the Week
 “ he shall cause the Sacrifice and the Obli-
 “ gation to cease, and (*as in the Margin*)
 “ upon the Battlements shall be the Idols of
 “ the Desolator.”

Josephus, who was a Jew, and lived to see
 these Things accomplished, could not help
 giving the Prophet Daniel, the following
 Character, ^(tt) “ That Daniel did not only
 “ foretell *Things to come*, which was common
 “ to

(tt) Joseph, lib. X. C. 12.

“ to him with other Prophets, but also *set a*
 “ *Time* for their coming to pass.”—He did
 not only foretell the Calamity that befell our
 Nation, from *Antiochus*, before it happened;
 but he also wrote of “ the *Dominion of the*
 “ *Romans*, and of the *great Desolation* they
 “ should hereafter bring upon the People.”
 And St. Matthew tells us, (uu) “ That the
 “ Disciples came unto Jesus privately, saying,
 “ when shall these Things be,” Jesus an-
 swered, “ When ye therefore see the Abo-
 “ mination of Desolation spoken of by Da-
 “ niel, the Prophet, *stand in the Holy Place*,
 “ (who so readeth, let him understand.) Let
 “ them which be in Judea, flee into the
 “ Mountains.—For then shall be great Tri-
 “ bulation, such as was not since the Begin-
 “ ning of the World to this Time —And
 “ they shall fall by the Edge of the Sword,
 “ (ww) (*in Number 1,100,000, says Josephus*)
 “ and they shall be led Captive, (*in Number*
 “ *says Josephus, 97,000*) into all Nations,
 “ and Jerusalem shall be trodden (*or inhabit-*
 “ *ed by Gentiles*) until the Time of the Gen-
 I “ tiles

(uu) Matthew XXIV, 3, 15, and 21.—(ww) Luke XXI, 24.

“tiles be fulfilled.”—Ver. 32, “Verily I
 “say unto you, *this Generation* shall not pass
 “until all be fulfilled,” *which it was in the*
70th Year of the vulgar Era. For

Josephus, who was an Eye Witness of the miserable Desolation by the Romans, tells us, ^(xx) of the Accomplishment of all these Predictions; when *Titus* laid Siege to the City; when Jerusalem was encompassed with the (*Roman*) Armies; when they cast a Trench about it, and enclosed it in on every Side; and when they caused the daily Sacrifices and Oblations to cease; and when *Titus's* Soldiers, in Spite of all his Endeavours to prevent it, set the Temple on Fire; and whilst it was in Flames, they set up the Standards of the Legions, on the Eastern Porch, and there they sacrificed before them after their idolatrous Manner. He also records the Month and Day of the Month when Jerusalem was taken and plundered, and the Temple destroyed; and remarks, that the second Temple was burnt by the Romans
 the

(xx) Lib. XI. Chap. 47.

the same Month, and Day of the Month, on which the first Temple was burnt by the Babylonians. Lib. VII. Chap. 9, 10.

Sixty-three Years after Daniel had made the above Prophecy of the Commandment, for the Return of the Jews, and for the restoring the Polity of Jerusalem, both civil and ecclesiastical, *Artaxerxes Longimanus* gave forth, (in the seventh Year of his Reign, A. M. 3550, which answers to A.I.P. 4256) his Decree and Command to *Ezra*, the Priest, ^(yy) “ to go up to Jerusalem, and with
“ him all the Priests and Levites, and all the
“ People of Israel, which are minded of their
“ own free Will, to go with him, and to
“ carry in his Hand the Silver and Gold,
“ which the King and his Counsellors had
“ offered unto the God of Israel, and all the
“ Silver and Gold, the free will offering of
“ the People and the Priests, and whatsoever
“ more shall be needful for the House of thy
“ God, which thou shalt have occasion to
“ bestow.”

Now

(yy) *Ezra* VII. 11 to 27.

Now let it be observed that the seventh Year of the Reign of Artaxerxes, begins and ends astronomically at the Vernal Equinox, as all Kings Reigns recorded in Scripture, after the Exodus of the Israelites out of Egypt, do.—Here begins the first Point of the Period of 70 Weeks, or 490 Solar Years, containing 365 D. 5 H. 49 M. each—and we are informed by Moses, ⁽²²⁾ that they numbered by Sabbaths of Years.

Now these 490 Years begin in the solar tropical Year of the World, 3550, when the sixth Year of the Reign of Artaxerxes Longimanus, King of Persia, ends, and the seventh Year of his Reign begins.—Now if to A.M. 3550 the 490 Years are added, it will make 4040, the Passover when the Messiah was cut off, as is proved by the Calculation at the End of this Introduction.—⁽¹⁾ Also, as the Mosaic Chronology places the Creation in the 706th Year of the Julian Period; so, if we add that Number to it, it will shew us that it was the 4746th Year of that Period when Christ suffered.

Ezra

(22) Levit. XXV. 8.—(1) Page .

Ezra informs us, ⁽²⁾ it was in the Month of Nisan, in the Beginning of the seventh Year of Artaxerxes, in the solar tropical Year of the World, 3550, when he set off from Babylon to restore the ecclesiastical and political State of Jerusalem.—And as may be observed by the Calculations at the End of this Introduction, it was on the 14th of Nisan, A. M. 4040, just 490 Years after Ezra received this Commandment, that the Messiah was cut off A. I. P. 4746, on the 3d of April, on a Friday, in the 19th Year of the Reign of Tiberius Cæsar, when Pontius Pilate was Procurator of Judea; when Daniel's Prophecy of seventy Weeks was completed, by the Death of Christ, who died on the Cross, on the Day, Hour, and Minute that the paschal Lamb was ordered to be Slain; for God directs it to be killed on the *fourteenth Day of the Month, between the two Evenings.* ⁽³⁾

That the exact Time may be known when the paschal Lamb was ordered by Moses to be slain, I will give you the Time according to

⁽²⁾ Ezra VII.—⁽³⁾ Exod. XII. 6.

to *David Levi*, who cannot be supposed to give a partial Account of it in Favour of Christ.—He tells us (4) the Manner of solemnizing the Passover while the first Temple stood.—“ It must be observed, (says he) that
 “ the Lamb was to be without Blemish, a
 “ Male, of the first Year, from the Sheep or
 “ the Goats, and brought to the Temple,
 “ and there to be killed on this fourteenth Day
 “ of Nisan, between the two Evenings, that
 “ is, according to the common and very an-
 “ cient Tradition, betwixt the Time of the
 “ Sun’s declining from his Meridian Altitude, till three o’Clock in the Afternoon,
 “ and from Three till Six: after which, the
 “ Sun going below the *Horizon*, the fifteenth
 “ Day commences.”—St. Matthew (5) and St. Mark (6) both tell us, that Christ gave up the Ghost the ninth Hour, which was at Three o’Clock in the Afternoon, or between the two Evenings, the Time precisely when the paschal Lamb was to be slain.—Thus, Christ died on a Friday, lay in the Grave all Saturday, or the Jewish Sabbath, and was
 raised

(4) Page 45.—(5) Matthew XXVII. 50.—(6) Mark XV. 34.

The INTRODUCTION. 71

raised again on Sunday, the Morrow after the Sabbath, when the original seventh Day was again restored, and kept as such by Christians ever since, which was the Day appointed to wave the Sheaf before the Lord, explaining and fore-shewing the Resurrection, which both our Saviour ⁽⁷⁾ and St. Paul tell us was typical, and gave us an Idea of it; for as the Grain was the first Fruits of the Earth, so was the Resurrection of Christ the first Fruits of the Spirit.

The first Christians were Jews; therefore, in order to keep a Memorial of the Birth of Christ, which happened as has been observed, at the Feast of Tabernacles; they took the *Boughs of green Trees*, to dress up their Houses and Churches, or Places of Worship, in the same Manner as the Israelites and Jews were commanded and used to do, and to dwell therein, and to rejoice therein, till the eighth Day, or Christ's Circumcision, or of the great Feast.—⁽⁸⁾ This Custom, this Memorial of the Birth of Christ, has been kept by Christians,

⁽⁷⁾ John XII. 24, and Corint. XV. 26, 23, 36.—⁽⁸⁾ Levit. XXIII. 39-

tians, without Interruption, from the Birth of our Saviour to this Time; and though now almost left off, except in our Churches, and amongst the common People, who do not think it Superstition to commemorate the Birth of Christ; but our fashionable Gentry are now so wise in their own Conceit, ⁽⁹⁾ that they think it Foolishness to believe any Mysteries at all; and Superstition to make use of Memorials or Ceremonies,—They are also so charitable to give the Name of Enthusiasts to all those who do; believing nothing but what they can explain, according to their own Reason or Imagination.—But this is contrary to the Instruction which St. Paul gives us, ⁽¹⁰⁾ that without Controversy, (says he) great is the Mystery of Godliness: God was manifest in the Flesh—that by Grace we are saved through Faith—⁽¹¹⁾ that Faith is the Substance of Things hoped for; the Evidence of Things not seen, ⁽¹²⁾ for we are saved by Hope; but Hope that is seen, is not Hope. ⁽¹³⁾

Now,

(9) Proverbs XXVI. 12.—(10) I. Tim. III. 16.—(11) Ephesians II. 8.
 (12) Hebrews XI. 1.—(13) Romans VIII. 24.

The INTRODUCTION. 73

Now, as I am going to conclude this Introduction, and begin my Calculations, with some critical Remarks on the Holy Scriptures, let the Reader join with me in Prayer to our God Jehovah, that he will open our Eyes, that we may behold wondrous Things out of thy Law, ⁽¹⁴⁾ and that his Holy Spirit may assist us with Grace, whereby we may serve God acceptably with Reverence and Godly Fear. ⁽¹⁵⁾

J. Penrose.

Stonehouse, Plymouth, Sept. 22.

In the Year of our Lord, 1787, (according to the Vulgar Era)

In the Year of the World, 5794.

In the Year of the Julian Period, 6500.

N.B. To prevent any spurious Editions being imposed on the Public, I shall sign my Name at the Bottom of the Diagrams, and at the Conclusion of the Introduction in each Book.

K

J. Penrose
CALCULATIONS.

(14) Psalm CXIX, 18.—(15) Hebrews XII. 28.

Having now concluded my Introduction, I shall add some Calculations of Equinoxes, new, full Moons, and Eclipses, to confirm what has been observed therein.—All of these begin at the Point wherein Moses places the Sun and Moon at the Creation, and they come out at the observed Time when they happened. Now,

If the unbelieving Deist, or the doubting Sceptic is not satisfied herewith, I call on either one of them, in the friendly Words of *Horace*, to find out one Equinox, full, new Moon, or Eclipse, which do not confirm it; if he cannot, let him shew Cause why he withholds his Assent to it; as the Sun and Moon bear Witness that it is as true as that they are in Heaven.

*Si quid novisti rectius istis,
Candidus imperti; si non, his utere Mecum.*

HORACE,

The Point I begin the following Calculations from, is the Autumnal Equinox, in the
the

the Year 706, of the Julian Period. The Sun, the Earth, Moon and her Node being then all in the first Point of Libra, when an Eclipse of the Moon must have happened, had they been in Being.—This is an exact Point to begin my Calculations, and from that Point, to the present Time, I calculate with a Mathematical Exactness. —I say, that Moses, (in his Account of the Creation, together with his Directions for keeping the Festivals, in Commemoration of that great Event,) has informed us, where the Sun and Moon were placed at that particular Instant of Time.—If my Calculations are true, you must admit that I received my Instructions either from Moses, or that I obtained them some other Way.—Now, it does not appear, that this can be obtained otherwise than either by Calculation, Observation, or Revelation.—As to the first it is impossible to be done; and, it could not be obtained by the second, as there was no Human Being to observe it; but Moses says, it was revealed by God, and to confirm his History and Chronology, he tells us the Places of the
Sun

Sun and Moon at that Time, which was 2370 Years before he was born; and this also at a Period of Time, when, (as the generality of People think) that all Sciences were in their Infancy,—But the following Calculations prove that his Relation is true. Is not this sufficient Evidence to prove any other History to be true; if so, why should Moses's History be excluded?

I have dated this Introduction, Sept. 22, A. D. 1787, which agrees with the 6500th Year of the Julian Period.—This is the real Day I have finished it; but, had it not been so, it would have been a very proper Day to have dated it from; as this Day, at 46 Minutes past Five in this Afternoon, ⁽¹⁶⁾ the Earth will have made and finished 5794 Revolutions through the Ecliptic, in the first Meridian; and in the Meridian of Greenwich Observatory, at ten Minutes past Four To-morrow Morning.—This is the precise Point of Time when A. M. 5794 ends, and 5795 begins, according to the Mosaic Chronology

(16) See Page 88.

nology of the World.—But as Moses directed the Israelites to measure Time by the Sun and Moon jointly, (whose Motions were to be a Check on each other, and by that Means to prevent any Mistake in keeping the Seasons) so it was measured by the Sun; and the Seasons were pointed out by the Moon. (17) Thus, as the Moon was fifteen Days old at the Creation, or a little past its Opposition or Full, so this Feast of Ingathering, (which was ordered to be observed in Commemoration of it,) was not to be kept, till the 15th Day of the Moon, next after the Sun had entered Libra. — Now, as has been observed, the Sun will enter Libra this Day, but the Moon will not be Full, or in Opposition to the Sun, at Greenwich, till Thursday the 27th Instant, at 22 Minutes past One in the Morning; and the Jews will begin their Feast of Tabernacles at Six o'Clock in the Evening. And with it they must celebrate the Birth of Christ, who was born on the first Day of that Feast, and circumcised on the eighth or the great Day; at which
Time

(17) Psalm CIV. 19.

Time the Moon will have made 71662 Lunations or Revolutions round the Earth.—The Length between these two Points has been measured by 2116214 Rotations of the Equator round its Axis, which being divided by 7, make 30216 Weeks, and leave in Remainder two Days, to which add the four Days of the Creation Week, (before the Sun and Moon were placed in Heaven to measure and point out the Seasons, the Days, and the Years,) and it will bring it to the Sixth Day of the Week, or Saturday, regularly from the Creation.—This proves, besides thousands of others, that Sunday was the original Seventh or Sabbath-Day.—The Saturdays Sabbath can claim no higher than the Exodus of the Israelites out of Egypt.

If this is not mathematical Demonstration that the Sun and Moon, in the Year 706, A. I. P. where in the Places which Moses informs us; I shall be glad to know in what it falls short of it.

CALCULATION

CALCULATIONS.

79

CALCULATION

Of the Eclipse which happened in the Year 4711, of the Julian Period; which was the 26th of Augustus Cæsar, during Herod's last Illness.

The Mosaic Chronology places the Year of the Creation in the 706th of the Julian Period; therefore if we subtract 706 from 4711, it will give 4005. The Year of the World answering to the 26th of Augustus Cæsar.

Subtract One to find where A. M. 4004 ends, and 4005 begins.



SOLAR.

SOLAR.

SOLAR.

A. M. 4004 Julian Years

Minutes $\times 12$ Julian Excess

4004

4004

Minute } $\div 1440$ 44044 (30 Days
in a Day }

844

Hours in a Day

 $\times 24$

3376

1688

 $\div 1440$ 20256 (14 Hours
1440

5856

5760

96

Minutes in an Hour $\times 60$ $\div 1440$ 5760 (4 Minutes
5760

(0)

SOLAR.

81

S O L A R.

4004
X 1461 Quadrants in a Year

4004
24024
16016
4004

		Days	H. M.			
Quadrants in a Year	}	$\div 4$	5849844 (0)	(1462461) 30	00 144	Julian Years Julian Excess

1462430 9 56 Sun in Libra, 1st Meridian

Add to bring Merid. of Jerufalem 13 4

1462430 23 00 Sun in Libra, Je-
rusalem.

Add, to Oct. 25. 298

Julian Biffext. 4004 1462728 23 00
1462461

	267	23	00
Aug. 31	243		

Sept. O. S. 24 23 00 at Jerufalem, P.M.
that is Sept. 25 11 0 O.S.

	1462728	23	00
add to bring to Aries	178	17	58

Julian Biftext. 4005 1462907 16 58
 1462826 6

Feb. 28 81 10 58
 March 22 O.S. 59
 March 22 O.S. 22 10 58 Sun in Aries, Jeru-
 rusalem.

L

LUNAR CALCULATION, A. M. 4005.

A. M.

Years in a Cycle $\div 19$) 4004 (210 Cycles
 38

 20

 19

 14

Lunations in a Year \times 12

 28

 14

 168

Intercalary Lunations 5

 173

210 Cycles

235 Lunations in a Cycle

 1050

630

 420

49350

Lunations 173

 49523 Lunations

CALCULATIONS.

83

LUNAR CALCULATION, A. M. 4005.

	Days	H.	M.	S.
In 40,000 Lunations are—	1181223	00	46	40
9,000 Ditto —————	265775	4	22	30
500 Ditto —————	14765	6	54	35
20 Ditto —————	590	14	40	35
3 Ditto —————	88	14	12	5

1462442 16 56 25

Subtract 1 Day for 49680 Lunations 1

Moon full 1st Meridian, Libra 1462441 16 56 25

add to bring to Merid. of Jerufalem 13 4

Moon full Jerufalem 1462442 6 00 25

To bring to Oct. 24. 297

1462739 6 00 25

Julian Biffextile 4004 1462461

278 6 00 25

Sept. 30 273

Oct. 5 6 00 25

and one Day for Apparition 7 Feast of Taber-

nacles when Christ was born

LUNAR CALCULATION, A. M. 4005.

	Days	H.	M.	S.
Moon full in Libra	1462442	6	00	25
add 5 Lunations to bring to Pisces	147	15	40	8
Moon full in Pisces	1462589	21	40	33
To bring to Oct. 24.	297			
Julian Bifextile 4005	1462886	21	40	33
	1462826	6		
Feb.	60	15	40	33
	59			
March O. S.	1	15	40	33
To N. S.	11			
	12	15	40	33 P.M.

Eclipse of the Moon in Herod's last Illness, March 12 D. 15
H. 40 M. 33 S. that is March 13 D. 3 H. 40 M. Morn.

	D.	H.	M.	
add Half Luration	14	18	22	
March N. S.	27	10	2	New Moon
Apparition	1	12	1	of Nifan
	28	22	2	
Add	14			of Nifan
	42	22	2	
March	31			
April	11			Paffover Even.

CALCULATION SOLAR, A. M. 4040.

*Of CHRIST's Death on the Cross.**

Minutes $\begin{array}{r} 4039 \text{ (Julian Years)} \\ \times 11 \text{ (Julian Excess)} \\ \hline \end{array}$

4039
4039

1440 $\begin{array}{r} 44429 \text{ (30 Days)} \\ 4320 \\ \hline \end{array}$

Hours $\begin{array}{r} 1229 \\ \times 24 \\ \hline \end{array}$

4916
2458

1440 $\begin{array}{r} 29496 \text{ (20 Hours)} \\ 2880 \\ \hline \end{array}$

Minutes $\begin{array}{r} 696 \\ \times 60 \\ \hline \end{array}$

1440 $\begin{array}{r} 41760 \text{ (29 Minutes)} \\ 2880 \\ \hline \end{array}$

12960
12960

(0)

* In the first Year of Darius the first, which answers to A. M. 3488, Daniel prophesied, (18) that a future Decree should be made for the Restoration of the Jews, (who were then in Captivity,) again to Jerusalem; and from the going forth of that Commandment, to the cutting off of the Messiah, should be 70 Weeks, or 490 Years.—63 Years after; and, after

two

(18) Daniel IX. 24, 25, 26, 27.

CALCULATION SOLAR, A. M. 4040.

Of CHRIST's Death on the Crofs.

	4039				
	1461				
	<hr/>				
	4039				
	24234				
	16156				
	4039				
	<hr/>				
÷ 4	5900979	D.	H.	M.	
	(3)	1475244	18	0	Julian Reduction
		30	20	29	Julian Excess
Solar Reduction	1475213	21	31		Sun in Libra, 1st Meridian
add to bring to Jerufalem		13	4		
		1475214	10	35	Sun in Libra, Jerufalem
add to bring to Aries		178	17	58	
		1475393	4	33	Sun in Aries, Jerufalem
add to bring to Oct. 25		298			
		1475691	4	33	
Julian Reduction 4040		1475610			
		81	4	33	
Feb.		59			
		<hr/>			
March O. S.	22	4	33		Sun in Aries, Jerufalem

two future Kings Reign, this Commandment was issued by Artaxerxes Longimanus, at the End of the Sixth and Beginning of the Seventh Year of his Reign, A. M. 3550, to Ezra, (19) to restore the ecclesiastical and political State of Jerufalem.—Now if we subtract 3550 from 4040, it will leave the 490 Years exactly, between issuing that Decree, to the cutting off of Christ. See Page 21.

CALCULATIONS.

87

CALCULATION, LUNAR, A. M. 4040.

Years in a Cycle \div 19 ^{A. M.} 4039 (212 Cycles)

38

23

19

49

38

Lunations

\times 12

132

Intercatory Lunations

4

136

212 Cycles

235

1060

636

424

Lunations

49820

136

49956 Lunations

1st of Nisan 1475391
before the Sun, extra. D. 4

7) 1475395 (210770
(5) Friday

to 14th of Nisan

14

7) 1475409 (210772
(5) Friday

CALCULATIONS.

CALCULATION, LUNAR, A. M. 4040.

	Days	H.	M.	S.
In 40,000 Lunations are	1181223	00	46	40
9,000 Ditto	265775	4	22	30
900 Ditto	26577	12	26	15
50 Ditto	1476	12	41	27
5 Ditto	147	15	40	8
$\frac{1}{2}$ Ditto	14	18	22	

1475214 16 19 0 Moon New, 1
Merid. Libra

Subf. 1 for 49680 Lunations 1

add to bring to Meridian }
of Jerufalem } 1475213 16 19 0
13 4

1475214 5 23 Moon New, Jeru-
falem, Libra

add to bring to Aries 177 4 24

add to bring to Oct. 24 1475391 9 47 New Moon 1 Nifan
297

Julian Reduction 4040 1475688 9 47
1475610

Feb. 78 9 47
59

March O. S. 19 9 47 1 Nifan
12

14 21 47

March 33 21 47
31

April P. M. 2 21 4 14 Nifan, Passover
when Christ died

Days from the Creation, to the 14th of Nifan, when Christ
died.

4 Days before the Sun 1475405
4

7) 1475409 (2107722 Weeks.
(5) 5th Day, Friday

I shall add one Calculation more in order to confirm what I have observed ; which will also be an Explanation to some of the following Letters.

In A. D. 1715 there was a remarkable and total Eclipse of the Sun, which was seen in London, about Ten o'Clock in the Morning. According to Mr, *Whiston's* Calculations, the Middle of it was April 22 D. 9 H. 51 M.—Therefore as this Eclipse was so well observed and recorded, there can be no Mistake about it ; and as it is so certain a Point, I shall calculate that Eclipse from the original Point at the Creation, when the Moon was Full and in her Node, and the Sun in the first Degree of *Libra*.—I shall then calculate from that Eclipse, to the Full Moon next Thursday Sept. 27, 1787.—This, if it comes out right, will be Demonstration, that the Point we calculate from, according to Moses's Chronology, is true, and that the Length of the Solar Year is exactly 365 D. 5 H. 49 M. and the Length of a Lunation 29 D. 12 H. 44 M. 1 S. 45 T. as we have assigned it.

M

The

CALCULATIONS.

The vulgar Era of Christ is placed in A. M. 4007, to which add A. D. 1715, and it will make A. M. 5722, to which add 706, the Number of Years the Julian Period begins before that Time; and it will bring it to the 6428th of that Period.

Subtract 1 from A. M. 5722, to make the Calculations at the End of that Year.

SOLAR CALCULATION.

A. M. 5721 Julian Years
 $\times 11$ Julian Excess

5721

5721

Minutes in a Day 1440) 62931 (43 D.

5760

5331

4320

Hours

1011

$\times 24$

4044

2022

1440) 24264 (16 H.

1440

9864

8640

Minutes

1224

$\times 60$

1440) 73440 (51 M.

7200

1440

1440

(0)

CALCULATIONS. 91

SOLAR CALCULATION.

5721 Julian Years

$\times 1461$ Quadrants in a Julian Year

5721
34326
22884
5721

Quadrants } $\div 4$) 8358331 (Days H. 0 Julian Re-
in a Day } (1) (2089595 6 duction
43 16 51 Julian Exc.

Sun in Libra, 1st Meridian	2089551 13 9
add to bring to Aries	178 17 58

Sun in Aries, 1st Meridian	2089730 7 7
add Meridian of Greenwich	10 24

	2089730 17 31
add for Oct. 25	298

	2090028 17 31
Julian Reduction, 5722	2089960

	68 17 31
To Feb. 28	59

March O. S. 9 17 31 P. M. that
is March 10, 31 M. past 5 Morning.

CALCULATION SOLAR, A. I. P. 6500. A. D. 1787.

A. M. 5794.

$$\begin{array}{r}
 5794 \\
 \times 11 \\
 \hline
 5794 \\
 5794 \\
 \hline
 1440 \overline{) 63734} (44 \text{ D} \\
 \underline{5760} \\
 6134 \\
 \underline{5760} \\
 374 \\
 \times 24 \\
 \hline
 1496 \\
 748 \\
 \hline
 1440 \overline{) 8976} (6 \text{ H.} \\
 \underline{8640} \\
 336 \\
 \times 60 \\
 \hline
 1440 \overline{) 20160} (14 \text{ M} \\
 \underline{1440} \\
 5760 \\
 5760 \\
 \hline
 (00)
 \end{array}$$

93

CALCULATION SOLAR, A. I. P. 6500.

5794
34764
23176
5794

	2116512	16	10
Julian Reduction	2116258		
	<hr/>		
	254	16	10
To the End of August	243		
	<hr/>		
Sept. O. S.	11	16	10
N. S.	11		

Days since the Creation.

1794
1

4) $^{1795}_{3}(44^8$ Year of Quadrienium

LUNAR CALCULATION.

$$\begin{array}{r} \text{Years in a Cycle } \div 19 \end{array} \begin{array}{r} \text{A. M.} \\ 57^{21} (301 \\ 57 \end{array}$$

$$\begin{array}{r} 21 \\ 19 \\ \hline 2 \\ 12 \end{array}$$

Lunations

$$\begin{array}{r} 24 \\ 6 \\ \hline (25) \end{array}$$

Intercalary

$$\begin{array}{r} 301 \text{ Cycles} \\ \times 235 \text{ Lunations in a Cycle} \\ \hline 1505 \\ 903 \\ 602 \\ \hline .70735 \\ 25 \end{array}$$

$$\begin{array}{r} 70760 \text{ Moon Full in Libra} \\ 6\frac{1}{2} \end{array}$$

to bring to Aries

$$\begin{array}{r} \text{Lunations in } \} \div 12 \begin{array}{r} 70766\frac{1}{2} \text{ Moon New in Aries} \\ 60 \end{array} \begin{array}{r} 5897 \text{ Lunar Years} \end{array} \\ \text{a Year} \end{array}$$

$$\begin{array}{r} 107 \\ 96 \\ \hline 116 \\ 108 \\ \hline 86 \\ 84 \\ \hline \end{array}$$

$$(2) \frac{1}{2} \text{ Lunations}$$

CALCULATIONS.

95

LUNAR CALCULATION.

Years in a Period $\div 30$) 5897 (196

289

270

197

180

(17) Years

Extra. Days 2089774
4

7) 2089778 (298539 Weeks
(5) Friday

	Days	H.	M.	S.
In 138 Periods are	1467078	(24)	9	00
50 Ditto	531550	8	45	00
8 Ditto	85048	1	24	00
17 Years are	6024	5	41	57
2 Lunations	59	1	28	3
$\frac{1}{2}$ Ditto	14	18	22	

New Moon, 1st Merid. Aries 2089774 11 50 0
add for Meridian Greenwich 10 24

add for Oct. 24. 2089774 22 14
297

Julian Reduction, 5722 2090071 22 14
2089960

To March 31 111 22 14
90

April O. S. 21 22 14 P. M. that is
April 22 D. 10 H. 14 M. in the Morning

LUNAR CALCULATION.

From the Eclipse A. D. 1715, New Moon Aries, and
add $895\frac{1}{2}$ Lunations. to bring to Full Moon in Libra, 1787.

	Days	H.	M.	S.
To 70766 $\frac{1}{2}$ Lunations	2080774	22	14	0
add 800 Ditto	23624	11	3	20
90 Ditto	2657	18	2	37
5 Ditto	147	15	40	8
$\frac{1}{2}$ Ditto	14	18	22	
	2116219	13	22	5
add to bring to Oct. 24	297			
	2116516	13	22	5
Subtract Julian Reduction, 5794	2116258			
	258	13	22	5
Calends of Jan. to the End of Aug.	243			
Sept. O. S.	15	13	22	5 Moon
				Full in Libra
add N. S.	11			
N. S.	26	13	22	5 P. M.
that is Sept. 27 D. 11 H. 22 M. 5 S. in the Morning				
A. M.				
5794				
1				
4)5795(1443				
3				
				of Quadriennium
Extra Days	2116219			
	4			
7)2116223(302317 Weeks				
(4)				Thursfday.

By our Calculations, both from the original Point of the Full Moon at the Creation, and also from the Eclipse which happened at London, 1715, there have been 71662 Lunations since the Moon was Full at the Creation, and that the last will end with a Full Moon next Thursfday Morning, Sept. 27, at 22 M. past One.

The

Of the Method made Use of in the foregoing Calculations.

The above Calculations of Equinoxes and Solstices are made in a different Manner from the Method generally used; which is, first to find the Places of the Sun and Moon in the Ecliptic, and then, by Equations and Anomilies, to make the 360 Degrees of the Equator to agree with the $365\frac{1}{2}$ Rotations of the Earth, through the Ecliptic.

These Calculations are not made in that Manner, but from the Method observed by Nature, viz. by the Number of Rotations the Earth makes between each of them; in the same Manner as Moses taught the Israelites to calculate their Seasons; and that in the most simple, easy, and (I will add) exact Manner, and requires no farther Knowledge in the Sciences, than the first four Rules of Arithmetic—and this Method I shall explain in as clear and concise a Manner as I can.

The Julian Period is a certain Measure of Time, for that Reason I calculate by that
N Period.

Of the Method made Use of in the foregoing Calculations.

Period.—But, as the Julian Year contains 11 Minutes more than the Solar Tropical, so we must subtract that Sum from every Julian Year, to make it agree with it.—Dr. Keil, in his XXVIIIth Lecture, has explained this in so clear a Manner, that I shall give it in his own Words.—“ It must be acknowledged, “ says he, that the Time appointed by Julius “ Cæsar, for the Solar Year, is too much ; “ for the Sun finishes his Course in the Ecliptic, in 365 Days, 5 Hours, and 49 Minutes ; and therefore he begins again his “ Round 11 Minutes before the Solar Year “ is ended : so that if the Sun in any Year “ has entered the Equinox upon the 20th of “ March, at Noon Day ; after four Years “ he will arrive at the Equinox 44 Minutes “ before Noon ; and so every Year, 11 “ Minutes sooner than by this Reckoning ; “ so that in 131 Years, he will *anticipate*, or “ enter the Equinox a whole Day before the “ 20th of March ; and therefore the *Celestial*
“ *Equinox*

Of the Method made Use of in the foregoing Calculations.

“ *Equinox* will not always fall upon the same
“ Day of the Month, but by Degrees it will
“ move towards the Beginning of the Year.”(a)

Hence, you may observe, in our first Calculation on the Birth of Christ, that we multiply A. M. 4004, by 11 Minutes.—The Product of which is the Number of Minutes that 4004 Julian Years contain more than 4004 Tropical Solar.—Then, in Order to bring these Minutes to Days, we divide that Sum by 1440, the Number of Minutes in a natural Day, or whilst the Equator compleats one Rotation from Sun to Sun.—The Remainder we multiply by 24, to bring it to Hours, and that Remainder by 60, to bring it to Minutes.

In Order to find the Number of Days, we multiply 4004 by 1461, the Number of Quadrants, or Quarters of a Day in a Julian Year.—We then divide the Product by 4, which

(a) See Diagram and Calculations.

Of the Method made Use of in the foregoing Calculations.

which brings them to Days.—If there is any Remainder, it is Quadrants.—Hence we have the Number of Days and Quadrants in 4004 Julian Years; from this Sum we Subtract the Days, Hours, and Minutes of the Retrocession, and the Remainder gives the exact Quantity of Days, Hours, and Minutes, in the same Number of tropical solar Years; and this, by Observation, will be always found exactly true, from the Creation to this Time.—Hence we can calculate the Day when the Sun will enter *Libra*, in any Meridian, but not the Hour and Minute.—This appeared the greatest Difficulty to get over, but by a lucky and accurate Observation of Dr. *Bradley*, A. D. 1753, it has answered our Purpose so far, as that all our Calculations made by it come out true.

1440 is the Number of Minutes in a Day, which has the same Number of Points or Terminations, on the Equator, answering to every one of them; so that in 1440 Years,
the

Of the Method made Use of in the foregoing Calculations.

the tropical solar Year will have began on every one of them, and at the End of that Period, the Sun will again begin a new Cycle, in the same Meridian, and on the same Point of the Day it did 1440 Years before, but not on the same Day of the Week, which is the Characteristick of each Cycle.

A. D. 1753 is in Connection with A. M. 5760, and A. I. P. 6466, when the fourth Cycle of the Sun was finished; and the Sun entered Libra on the same Point of the Day, the same Hour and Minute it began it 1440 Years before. (b)

Dr. Bradley observed it to enter Libra that Year, at Greenwich, Sept. 22d Day, 10th Hour, 24th Minute.—Now, as the Sun was placed in Libra, at the Creation, at Noon, in the first Meridian; but, at the Time when he made his Observation, it was passed on 10 Hours, 24 Minutes to the Westward; by turning Time into Measure, the first Meridian

(b) See Page 24.

Of the Method made Use of in the foregoing Calculations.

dian will be found to be 156 Degrees to the Westward of Greenwich Observatory.—We have accordingly made this the Root, and postulated it as true, and have found all our Calculations to turn out right on that *Postulatum*.—As Jerusalem is $35^{\circ} 20$ M. of Longitude, East of Greenwich; so if we turn this Measure into Time, it will produce 2 Hours, 40 Minutes, which added to 10 Hours, 24 Minutes, (the Meridian of Greenwich) it will make 13 Hours, 4 Minutes.—On this Principle the above Calculation was made; and by it the Sun was found to enter Libra that Year at Jerusalem, Sept. 24th D. 23d H. 0 M. P. M. that is Sept. 25th Day, 11th Hour, 00 Minutes, Morning.—To which we add 178 Days, 17 Hours, 58 Minutes, the Distance between the first Point of Libra, and the first Point of Aries; by which the Sun was found to enter Aries at Jerusalem, March 22d Day, 5th Hour, 58th Minute, P. M. or Afternoon.—As the Sun was placed in Libra, Oct. 25th, A. I. P.

Of the Method made Use of in the foregoing Calculations.

706, according to the Julian Calendar, so, in all our Calculations, we add 298 Days to the Sum, (the Number of Days from the Calends of January, to Oct. 25, when Time began) and then subtract the Julian Reduction from it.—The Remainder will give the Day of the Julian Month sought.—Hence, as the first of the Month was not to be counted from the *Synod*, but from the Apparition, we postulate that the Moon, if she had been in Being, would be in one of her Nodes, and exactly opposite to the Sun, on the third Day of the Week, just 24 Hours, or one whole Day, before the Sun entered *Libra*.—This is a most exact Point, and from it we begin all our Calculations, and they always come out according to the observed Times; this we call the original Radix or Root, and from this Root we calculate by Years and Lunations, and those Years and Lunations, are measured by Days.—In all these Calculations we make the tropical solar Year to contain 365 Days, 5 Hours, 49 Minutes

Of the Method made Use of in the foregoing Calculations.

minutes precisely, and a Lunation 29 Days, 12 Hours, 44 Minutes, 1 S. 45 T.

It may be observed by these Calculations, that in every 49680 Lunations, we throw off one Day.—This Day is thrown off for much the same Reason that 11 Minutes were thrown off every Year from the solar Computation.—For in a Period of 30 Years, the Reckoning over-runs the compleat Days, 10 Minutes and 30 Seconds.—In this determinate Proportion, the Moon makes a slow, gradual, and uniform Progression quite round the Ecliptic, and in 49680 Lunations, gets a Day, in the same Manner as the Sun gets one Day in 131 Years, according to the Julian Reckoning; therefore it must be discharged, otherwise we shall count one Day more than is performed by Nature.

Before the late Regulation, it had been observed, that the lunar Reckoning had *anticipated* the Astronomical four Days, and so much

Of the Method made Use of in the foregoing Calculations.

much Difference there were between the Ecclesiastical and Astronomical Full Moons.— This Anticipation was attributed to the Moon being now nearer the Earth than she was some Years ago, and that she performed her Lunations in less Time now than she did formerly ; and what appears the more extraordinary is, that Astronomers should ascribe these lunar Anticipations to the Moon's coming to the End of the lunar Cycle of 19 Years, one Hour and Half before the Sun ; whereas, it may be observed, by comparing the 19 Years Cycle of the Sun and Moon together, that instead of the Moon coming to the End of that Cycle an Hour and Half before the Sun, the contrary is the Fact ; for the Sun comes to the End of the Cycle 1 H. 55 M. 51 S. 15 T. before the Moon.—

Here it follows.

	Days	H.	M.	S.	T.
A Lunar Cycle containing 235 Lunations	6939	16	26	51	15
A Solar Cycle of 19 Tropical Solar Years	6939	14	31	00	00
Excess of Lunar Computation above the Solar	1	55	51	15	

O

From

Of the Method made Use of in the foregoing Calculations.

From the above it may be remarked, that the Contrary to what Astronomers maintain is true, viz, that the Moon comes to the End of the Cycle before the Sun; she indeed departs from the Sun at the End of every Cycle, but then it is by a Progression Eastward, and not by a Retrocession Westward; for the New Moons and Full Moons in that Space of Time fall out almost two Hours later, and not an Hour and Half sooner.

On comparing 19 Julian Years with 19 Lunisolar, we shall find that the Julian Reckoning over-runs the Lunar 1 H. 33 M. 8 S. 45 T. just in the same Manner as it was observed the Julian Year over-runs the Tropical Solar; and must be expunged for the same Reason.—Here follows the Comparison.

	Days.	H.	M.	S.	T.
19 Julian Years contain	6939	18	00	00	0
19 Lunisolar Years contain	6939	16	26	51	15
Excess of the Julian above the Lunar—		1	33	8	45

Hence

Of the Method made Use of in the foregoing Calculations.

Hence appears the Reason why Astronomers maintain, that in 19 Lunifolar Years, the mean New Moons and Full Moons happen an Hour and Half sooner, than they did at the Beginning of the Cycle.—Instead of which, it is found, on comparing 19 Solar with 19 Lunar, that the Sun comes to the Point where they set out from together, 1 H. 55 M. 51 S. 15 T. (which wants but 4 M. 8 S. 45 T. of two Hours) before the Moon. But that the Julian Reckoning over-runs the Lunar, 3 M. 8 H. 45 T. more than an Hour and Half in every Cycle; which, (like the 11 Minutes Difference between the Julian and tropical solar Year) has been the Occasion of the *apparent Anticipation*; which has no Foundation in Nature, but owes its Existence entirely to a mistaken Computation.

Having premised thus much, I shall finish this Explanation with giving an Account of the Method used in the Lunar Calculations, and for that Purpose, shall explain the Calculation,

Of the Method made Use of in the foregoing Calculations.

culatation, P. 94, where the total and central Eclipse of the Sun, which was observed in London, A. D. 1715, is calculated from the original Point of the Full Moon, the third Day of the Creation; to that very Point when it was observed at London; and from that Point, to the Full Moon next Thursday Morning, Sept. 27th.

The Year of the World answering to 1715, has been found to be A. M. 5722, from which we throw off One, as was observed in the Solar Reckoning, and then divide 5721 by 19, the Number of Years in a Cycle, which gives 301 Cycles, and leaves in Remainder $\frac{2}{19}$ of another; we then multiply the Remainder 2 by 12, the Number of Lunations in a Year; which make 24 Lunations. --And, as about one Month is intercalated every three Years, to make the Computation agree with the Solar, we add One to this Sum, which makes 25 Lunations. — We then multiply these 301 Cycles, by 235, the

Of the Method made Use of in the foregoing Calculations.

The Number of Lunations in a Cycle, which give 70735; to which we add the 25 remaining Lunations, these make 70760, which brings it to the Full Moon at the autumnal Equinox; but, as this Eclipse happened at a New Moon, near the vernal Equinox, we add Six Lunations to bring it thereto, and Half a Luration to bring it from the Full of the Moon, (at which Point all these Lunations end, as they began at that Point at the Creation) to the New.—These make in the Whole 70766½.—We then divide these Lunations by twelve, (the Number contained in a Year) and that gives 5897 lunar Years, and leaves 2 Lunations and Half in Remainder. To bring these to Periods of 30 Years, we divide 30, which gives 196 Periods, and 17 Years of another Period.—We then add the Periods and Lunations together, which makes 2089774 Days, 11 H. 50 M. which is the Distance between the Full Moon at the Creation, and the Eclipse of the Sun, which happened in 1715, in the first Meridian; but in
Order

Of the Method made Use of in the foregoing Calculations.

Order to bring it to the Meridian of Greenwich Observatory, we add 10 H. 24 M. which makes 2089774 Days, 22 H. 14 M. for the New Moon at Greenwich.—Then, as the Calends of January are 297 D. before Oct. 24, we add that Sum to it, as we did 298 in the solar Computation, to bring from the Calends of Jan. to Oct. 25, which is one Day short of the Solar Reckoning, as the Moon was Full one whole Day before the Sun began to measure Time at the Creation. With this Addition to the above Sum it makes 2090071 Days, 22 H. 14 M.—From which we subtract the Number of Days of the Julian Reduction, for A. M. 5722, which leaves 111 Days, 22 H. 14 M. from the Calends of January; from thence, to the last Day of March inclusive, are 90 Days, which we subtract from the above Sum; and then find that the Point of Time, when the Moon intersected the Path of the Earth, in Conjunction with the Sun, was April 21 Days, 22 H. 14 M. P. M. that is April 22 D. 10 H. 14 M.

EXPLANATION

III

Of the Method made Use of in the foregoing Calculations.

14 M. in the Morning.—Thus it may be observed, that our Calculation differs only 23 Minutes from Mr. Whiston's; which, supposing Mr. Whiston's to be precisely true, is but a very little, considering the Length of Time of 70766 Lunations, or 5722 tropical solar Years.

In Order to know the Day of the Week when this Eclipse happened, we divide 2089774 Days, the Number of Rotations the Equator has made between the fourth of the Creation, and that Point, (when the Moon intersected the Earth's Path) by 7, the Number of Days in a Week, first adding 4 for the first 4 *extra* Days, before the Sun began to measure Time; and it will give 298539 Weeks, and leave in Remainder 5, (*Friday*) the fifth Day of the Week.

Between that Eclipse and the Full Moon which will happen next Thursday, Sept. 27, there will have passed $895\frac{1}{2}$ Lunations—

We

Of the Method made Use of in the foregoing Calculations.

We therefore add the Quantity of these Lunations together, and find it to contain 2116219 Days, 13 H. 22 M. 5 S. We then add 297 Days, to bring it to Oct. 24, after subtracting the Julian Reduction for this Year, A. M. 5794, it leaves 258 D. 13 H. 22 M. 5 S. from which we subtract 243, the Number of Days from the Calends of January, to the End of August inclusive; and we shall have Sept. 15 D. 13 H. 22 M. 5 S. P. M. for the Full Moon this Year, in *Libra*, which is according to our Reckoning, Sept. 16 D. 1 H. 22 M. 5 S. P. M. O. S. to which we add 11, to bring to N. S. and then it will be Sept. 27th, at 22 Minutes, 5 Seconds past One in the Morning.

For the Day of the Week	2116219 Days
Extra Days	4
	<hr/>
$\div 7$	2116223
	(4) 302317 Weeks
	Thursday

I now hope I have given *demonstrative* Evidence that what I asserted is true, viz. that
Moses

Of the Method made Use of in the foregoing Calculations.

Moses has given us an Account of the Place of the Sun and Moon at the Creation ; which, according to his Chronology, happened at a Full Moon, at the autumnal Equinox, in the 706th Year of the Julian Period.

I am now willing to join Issue with the doubting Sceptic, and bring my Cause to be tried and determined by the discerning Public.—I shall beg Leave to sum up the Evidence of this last Calculation *only*.

The Matter at Issue is, whether Moses in his History of the Creation, has given us Instruction, where the Sun and Moon were placed at that Time —It appears to me that he has done it, and I postulate it as true, viz. that the Sun was placed in *Libra*, on Oct. 25, according to the Julian Reckoning, at Noon, in the first Meridian, on Thursday the fourth Day of the Week.—That the Moon was 15 Days old ; that had she been in Being, she would have been directly in

P

Opposition

Of the Method made Use of in the foregoing Calculations.

Opposition to the Sun, on Wednesday Noon, the third Day of the Week, and in her Node, Oct. 24, according to the Julian Reckoning, and that she would then be totally and centrally eclipsed; and that this happened in the Year 706, of the Julian Period.—This is the *first* or *original* Root or Point from whence I begin all my Calculations.—The Point I measure to is a most certain One; and was observed by many Thousands of People.—It is the Eclipse of the Sun which happened at London, on a Friday, April 22. The Middle of which, according to Mr. Whiston's Calculations, was at nine Minutes before Ten in the Morning.—This was in A. D. 1715, and we know this Year was in Connection with 6428 of the Julian Period. Now as the Mosaic Chronology places the Year of the Creation in A. I. P. 706; if we subtract 706 from 6428, it will give 5722, the Number of the annual Revolutions which the Earth has made between these two Points; which this Eclipse proved to be exactly true.

From

Of the Method made Use of in the foregoing Calculations.

From this Point to next Thursday, Sept. 27, at twenty-two Minutes past One in the Morning, there will have passed 26444 Rotations of the Equator, and as much as measured 15 H. 8 M. 5 S. besides.—Now the first Point of this second Calculation begins at London, at the central Point of the total Eclipse, 1715, and ends at 22 Minutes past One in the Morning, on Thursday, Sept. 27. Between these two Points, the Moon will have made $895\frac{1}{2}$ Lunations—that is, from her Conjunction with the Sun, A. D. 1715, to her Opposition, 1787.—This is the lunar Measure between these two Points.—The solar Measure will be found to agree with it. Our first Point of solar Measure is Oct. 25, at Noon, A. I. P. 706, when the Sun entered *Libra*, in the first Meridian, on Thursday the 4th Day of the Week.—Our next Point is this Day, Sept. 22, when the Sun will be found to enter *Libra* in the Meridian of Greenwich, at ten Minutes past Four Tomorrow Morning, A. I. P. 6500.—Between these

Of the Method made Use of in the foregoing Calculations.

these two Points, the Earth will have made 5794 annual Revolutions through the Ecliptic, which she has performed in 2116214 D. 16 H. 10 M. and will end To-morrow Morning, the 7th Day of the Week or Sunday, at ten Minutes past Four.

The first lunar Calculation began at the original Point, at the Creation, and ended at the total Eclipse of the Sun, A. D. 1715.—The second began at the Point where the first ended, and finished at the Full Moon, Sept. 27, at 22 Minutes past One in the Morning.—By comparing the Sum of these two lunar Calculations, we shall find them to agree exactly with the solar Measure, begun at the original Point, at the Creation, and ending To-morrow at ten Minutes past Four in the Morning.—Here they follow.

	Days.	H.	M.	
Lunar Measure	2116219	13	22	Sunday
Solar Ditto	2116214	16	10	Thursday

4 21 12

It

Of the Method made Use of in the foregoing Calculations.

It may be observed, that the Difference between the solar and lunar Measure is 4 D. 21 H. 12 M. and wants but 2 H. 48 M. of five Days Difference between the lunar and solar Reckoning; but between Sunday and Thursday, there are only four Days — It must be remarked, that the Moon was Full one whole Day before the Sun began to measure Time, therefore one Day must be subtracted from the lunar Computation, which makes the exact Difference to be 3 D. 21 H. 12 M. as appears by these Calculations. — Does not this prove to Demonstration, that what I have postulated is true?

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THE following Letters were occasioned by a Tour of Mr. Heaviside and Mr. Penrose, through Cornwall, A. D. 1783, to view and examine, the Nature of the Mines, Clifts, Druid Monuments, and other Antiquities found there:—This, as may be imagined, occasioned many Observations and Remarks, in Order to account for the different Phenomena seen.—Hence, Mr. Heaviside, in his Letter to Mr. Penrose, after his Return to London, from Plymouth, sent him some Observations he made as he passed over the Mendipp Hills, with some Queries.—The first Letter is an Answer to them.

LETTER I.

TO JOHN HEAVISIDE, Esq.

An Answer to some Queries proposed by Mr. Heaviside ; whether Ore, Metal, or Coal were ever found under Chalk ?—Observations where Ore and Metals are found, with Remarks on the Formation of the terraqueous Globe.—How Metals, Salts, &c. were dissolved, and reformed at the Deluge ; together with the Method by which the different Strata were formed.—The Flood described.

DEAR SIR,

YOUR Favour, with your judicious Observations on the Mendipp Hills, I received ; with your *Quere* whether Ore, Metal, or Coals are ever found under Chalk ?—In Answer to which, I observe, that I have not met with any Account that either of the above have ever been found under such a *Stratum* ; Coals, as you remark, are found under *Strata* of Stone and Clay.—Ore and Metals

Metals are generally (though not always) in Fiffures of large hard Strata of Stone; which *Strata* were formed and *cracked before* the Metals were deposited in these Fiffures and Cracks; indeed, Lead is often found in crumbling Ground; and Iron sometimes in Floats—the philosophical Cause of which require more Room to discuss, than can be contained in a common Letter.—Besides, Philosophers are not yet agreed, how, and in what Manner, or by what Agent or Agents, this terraqueous Globe was formed—therefore, it will be no easy Matter for me to explain it in such a Manner as to gain a general Assent; supposing my Theory to be true—and however satisfactory it may be to myself, it may not be so to others.—One great Difficulty is, that the *Stratum* of the greatest specific Gravity is not always the lowermost; but, when we suppose, that before these different *Strata* subsided, every Thing was in the greatest Confusion; and also, that the greatest Part of every *Stratum*, as deep as has been examined, (if not the Whole) was in a State of Solution; so it may appear likely, that

that it remained in this Manner till it met with a Fluid, of quite a different Nature; (which from the great Disturbance and Confusion this would occasion,) it would let fall its earthly Contents, in the same Manner as we often see performed in Chymical Operations; particularly in the making of *Magnesia Alba*.—The acid Salt being dissolved in Water, is quite clear and transparent; as is also the Alcaline Salt dissolved in the same Manner;—these will continue clear and transparent nearly as long as you choose, if you keep them separate and apart, but mix them together, and they will immediately become very turbid, and let fall a large Sediment or *Stratum*; and after a Time, the incumbent Liquor will become clear again; but if this Liquor is not entirely freed from all its saline Parts, whether they be acid or alkaline, add to it a Solution of the other, they will again become turbid, and let fall their Contents, and this *toties, quoties*, as often as this is done, till all the earthly Parts are subsided. Operations of this Kind give us an Idea of the Solution of the earthly Parts, which were

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dissolved

dissolved at the Deluge, and again subsided in different *Strata*, as we observe them at this Day: Hence we may understand the Cause why every *Stratum* is not found to have settled *exactly* according to its specific Gravity. Hence also we must imagine, that if any *Exuvia* of Animals or Vegetables were mixed with these Fluids, that they would be carried down together with the earthly Matter, and be mixed throughout the *Stratum*, in the Manner we find them at this Day.

From Observation we also find, that Metals of all Sorts will dissolve in particular Fluids, as Gold in *Aqua Regia*, other Metals in *Aqua fortis*; there are also Solvents that will dissolve all Sorts of Salts and precious Stones; these Liquids, after the Solution, appear as clear as pure Water; but on being mixed with a Fluid of a different Quality, become turbid, and let fall their Contents.—Hence we may easily conceive how the different *Strata* of the Earth were formed, and by what Means some of the Strata of Stone, Clay, &c. were loaded and filled with the different

different Exuvizæ of Animals and Vegetables. But then perhaps the following Question will be asked—if it was so? how comes it that Metals did not subside in the same Manner, and not remain suspended, till after the earthy *Strata* were so far hardened as to be cracked in different Fissures; after which the different Metals filled these Fissures together with Spar and other saline Concretions of the same Kind? To answer this Question we must again have Recourse to the different Effects produced by Chymical Operations; but it will be proper first to explain how these different Cracks were produced.—It appears by the Account Moses gives of the coming on of the Flood, that they were occasioned, in a great Measure, by breaking up the Fountains of the great Deep, and opening the Windows of Heaven. (a) Now it is observable, that God says to Noah, *I, even I,* (b) *do bring a Flood of Waters upon the Earth*, thereby letting him know that it would be a Miracle, performed by God himself,

(a) Gen. VII. 11.—(b) Gen. V. 17.

self, and brought about contrary to the *Mechanism* of Nature.—But then, notwithstanding it was brought on by his Order, and contrary to the Mechanism of Nature; yet, he would now, as he did at the Formation, make the material Agents perform it.—Thus he made the *internal* Expansion act with greater Power; and by this Means force out the Water of the great Deep, through the Fountains and Windows of Heaven; (c) by this Means the Place or Centre of Gravity being altered, and the Cause of the Attraction of Cohesion being taken away, they were made to dissolve and cover the Earth.—Now the Power of the internal Expansion being ordered by God to be of a *just Strength, to throw out the Waters, so as to cover the Hills fifteen Cubits upwards, and no farther.* And being then restrained by the Agency of the outward Expanse or Pressure of the Ethers and Air—these two Powers acted much in the same

(c) These Windows of Heaven, according to the Hebrew, are the Cracks and Holes in the Earth, which, before this Event happened, were filled with the same Ethers as fills the Heavens, but were now so enlarged, as to admit the Water through them.

same Manner they did at the Formation.— And the Power or Effect of Gravity was made to act both within and without the Waters, which were then a compleat Globe, covering all the earthy Parts.—The internal Expansion, acting in this Manner, in the Midst of the Globe, forced Gravity to effect the same outward, from the Centre, as it did on the Outside towards the Centre; by these Means a solid Shell of the earthy Parts was formed between the outward Surface of the Waters, and the inward Surface.—After this the internal Expansion still increasing, and by the Closeness of the earthy Shell, being prevented from finding its Way outward, its expansive Force gradually distended, the incumbent *Strata*, (like a Bladder forceably blown) and opened the Cracks and Fissures more and more, till a violent Explosion ensued, which tore the Globe into Millions of Fragments, and threw them into every possible Degree of Confusion; some of them more elevated, and others more depressed: Hence arose an indefinite Number of subterraneous Caverns, for many Miles, and some for many
Hundreds

Hundreds of Miles.—After this *God remembered Noah*, (d) (and used the same Agent then as he did at the Formation) and *caused a Wind*, or *Etherial Spirit* to pass over the Earth, which quieted the Waters, and *made them recede*, (e) and by this Agent he also made Gravity to act again, towards the Centre, till the Waters were forced to their proper Place, where the gravitating Ethers, (as God commanded) (f) *shut the Sea with Doors*, *when it brake forth, it had issued out of the Womb*; *when he made thick Darknes a swadling Bond for it*; and said, *hitherto shalt thou come, and no farther*: Here shall thy proud Waves be stayed: Here is a Bound sat that they may not pass over; that they turn not again to cover the Earth.

Having in short explained the coming on the Waters of the Deluge, the Destruction of the Earth thereby, and its Reformation; I shall now endeavour to answer your Question, why the Metals did not subside with the
earthly

(d) Gen. VIII. 1.—(e) This is a literal Translation of the Hebrew.

(f) Job. XXXVIII. 8, 9.

earthy Matter, but were placed in the Fissures we now find them, which must have been done after these Fissures were formed?

In the first Place it must be observed, that Metals require a stronger *Menstruum* than mere Water, to dissolve and take up their Parts; and also that they are separated from one another with greater Difficulty; and Salts or Gems, require some of the watery Parts to be evaporated, before they will run into Chrystals, or separate from the Liquid; besides as they require a *Menstruum saturated with proper Salts*, before they will be dissolved, and sustained in them; so they must also meet with another *Menstruum*, well stocked with Salts of an opposite Nature, before they will let their Contents fall again, and perhaps might require the additional Heat which the Waters received from the internal Fire to do it.—Hence the metalline and chrySTALLINE Particles, might not separate till the greater Part of the Water was run off the Earth, when they were forced into the Cracks and Fissures.— Thus, we observe,
that

that Gold is dissolved by *Aqua Regia*, a particular saline Fluid! whilst all other Metals are dissolved by *Aqua fortis*.—Hence, Gold is found often in the Earth or Sand, pure, and without the Mixture of other Metals; but Silver, Tin, Lead, Copper, &c are often found mixed, and incorporated in the same Mass; to which generally is added Spar, which from its Transparency, angular Form, &c. appears to have Shot, and to be formed in the same Manner as (other) Salts.—Quere, Are not Diamonds formed after the same Manner?—Now, if the different *Strata* of the Earth were formed as above described, it seems natural to imagine, that they would carry down with them the different *Exuviae*, as Shells, Vegetables, Wood, Bones, &c. which were contained therein, though of different specific Gravities to the *Strata when formed*; and there remain mixed with the *Strata*, in the same Manner as they are now found.

According to your Desire, I have sent you some short Hints of my *Ideas* concerning the
Destruction

Destruction and Reformation of this terraqueous Globe; the Errors you find therein, your superior Judgment will easily correct; and what they are, let me know in your next Epistle.

I am,

DEAR SIR,

Your obliged,

And obedient,

Humble Servant,

F. Penrose.

STONEHOUSE,
Aug. 1, 1783.

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On

TO F. PENROSE, ESQ.

Mr. Heavyside's Answer to the former Letter, with his Remarks thereon; together with his Theory of the Deluge.—That he cannot think that the Earth underwent a general Dissolution, at that Time; that he believed the central Nucleus was Fire; with Objections to the Dissolution of the Earth at the Deluge.

DEAR SIR,

I Am much obliged to you for your Answer to the Quere in my last; it was a sudden Question which arose in my Mind on seeing those Hills; and I neither did, nor do, recollect ever to have met with it in the Course of my reading; and if it has never been touched upon by any Naturalist, it seems very surprising, for it appears to me to be well worthy the Observation of one.—To give a Reason why Metals may not be equally found under Chalk, as under Stone, may not indeed be so easy, as 'tis to make the Observation.—

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I must also thank you for the Trouble you suffered that Quere to cause you, by explaining your Theory of the Earth, and desiring my Opinion of it.—But, really, Sir, my Opinion in these Matters is of very little Value; for to tell you a Truth, my reading has always been desultory and varied; for as Objects presented themselves to my Mind, I pursued them either till I was tired of them, or new ones started to turn the Current of my Thoughts another Way: But I never studied any Science methodically or scientifically, nor ever had any one to encourage or assist me in any Pursuit I entered upon; so that you must not expect any regular, well-digested System from me: However, as you desire it, I will give you my Thoughts just as they arise at this Moment of my Writing; but, not having Leisure to digest them, will probably be confused enough.—First, then, I must tell you, that I agree to your Theory *in Part*, but not wholly; because I do not think that the *general* Dissolution of the Earth, at the Deluge, (which you suppose) either did or could take Place; nor could it
have

On the DELUGE. LET. II.

have produced the present Appearances, if it had.—But that a partial Diffolution of the *earthly* Parts, Sand, Gravel, &c. &c. was caused by it, I readily assent to; yet I cannot think that the immense Bodies of Rocks that now exist in the World, were ever *in fluore* since they were first formed at the Creation. My own Idea is in short this; when the World was first formed out of the chaotic Matter, the central *Nucleus* was Fire, and that it was enclosed in a Shell or Case, formed of some of the heaviest Particles, such as Marble, Stone, &c. and that the other component Particles took their Places, not indeed exactly according to their specific Gravities, but perhaps nearly so; that the Waters drained off into the hollows, or lowest Parts of the Surface, and formed the Sea.—That at the appointed Time, this central Fire burst its *stony Shell*, with a violent Explosion, and was *one* great efficient Cause of the Deluge.—And as this Earth or Crust must necessarily have been *thinnest*, where those deep Hollows had been made to receive the *Sea*, so probably those Parts would
first

first yield to the Force of the Explosion, and be thrown farthest from the Center, as being lightest, and consequently form the *highest* Parts of our present Globe, such as the Andes, Alps, &c. and (if you please) the Mountains of Cornwall; all of which are of Rock. That the violent Agitation of the Waters, caused by this Explosion, would, *in many Parts*, wash much of the earthy Particles which covered these Rocks in their pristine Situation, from them; and thereby leave them in the naked State we now see them *in many Places*: but that in others, where the rocky Shell was not forced up quite so high, it remains covered with the different *Strata* of Sand, Shells, &c. much in the same Manner as it did when it originally made a Part of the great Basin which contained the Sea, which seems to me to be a very natural Solution of the Phenomenon of Shells, &c. being found even on very high Mountains; and different Sorts of them in different Places; as we now find that the different Sorts of Shell-fish, as well as others, are found in much greater Quantities in some Parts of our Seas than in others. On

On this Principle it is likewise easy to conceive, how those Fissures were caused in the hard Rocks of Cornwall and Derbyshire, &c. which are now filled with what they call the (Metallick) *Load*: but whether that *Load* was originally in the State it is now found, I very much doubt: My own Opinion being rather that they have been gradually formed by the Admixture of certain impregnated Fluids, with earthy Particles properly adapted to receive them, and become the Basis of Mineral Substance.

And what inclines me to this Opinion, and confirms me in it, is my own Observation of the Formation of what are vulgarly called Plumb-pudding Stones; which I have seen in the State of *loose Gravel*, and watched it through all the Gradations between that and the hardness of a Granite: I have also seen a small *Ruby*, in the Center of a *Diamond*, which incontestably proves that the Ruby was formed before the constituent Parts of the Diamond, which must then have been in a Fluid or soft State, for otherwise they could not have surrounded and enclosed it.

But to return, and give you my Objections to *Part* of your Theory; if, as you suppose, all the terraqueous Globe was in a State of Solution at the Time of the Deluge, how could the Rocks of Marble and Granite, acquire such great Hardness and Solidity, in so short a Space as one Year, to admit of being cracked and split as we now see them.— Would they not rather have admitted of being arched or bent, as being in a *softer* State? But, admitting for Argument's Sake, that they could have acquired sufficient Hardness, what Force, or what Cause could have been applied to them *since then*, sufficient to crack, break, and tumble them about in the wonderful Manner we now see them? You will observe, that we so far agree about the Formation of Ores, in these *Cracks*, as to suppose them formed there, subsequent to those *Cracks*: But whether you will agree with me, that they were formed upon a Matrix of earthy Particles, by Impregnation from Fluids, I know not; but I rather think you will, from the Instance you properly bring of Spars being found among them, which
every

every one knows are formed from aqueous Particles, loaded with what may properly enough be called Saline ones.

Thus, my Dear Sir, you have a hasty Sketch of my Philosophy, the Product of the first leisure Hour I have had since my Return to Town.

I am,

DEAR SIR,

Your very obedient,

And much obliged Servant,

J. HEAVISIDE.

Prince's-Street, Oct. 10, 178g.

TO JOHN HEAVISIDE, Esq.

Facts which prove that all Parts of Europe, Asia, Africa, and America, the Exuviæ of Animals and Vegetables, particularly Sea Shells, are found in different Strata of Stone, both on the Tops of the highest Mountains in the World, and also at the greatest Depths that have been dug below the Surface of the Earth.—Some farther Account of the Deluge.

DEAR SIR,

THOUGH we cannot *exactly* agree in our Ideas about the Formation of the Earth, *at the Creation*, and the Destruction (as I suppose) and Reformation of it at the Deluge; yet the genteel and impartial Manner in which you mention your Objections, shews that Truth is your Object.—And, I am sure, that no one, who reads your Observations, but must think (notwithstanding what you say) that you have made some Proficiencies in the Study of Natural Philosophy,

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I believe you have been teased enough already, to know that it is my Hobby-Horse. As Uncle Toby had his, so I have mine; for when Philosophy is once made the Subject of Conversation, I dont know when to have done with it; and therefore, I suppose, you will desire no more on the Subject; if so, throw this in the Fire, and trouble yourself no more about it.

It gave me great Satisfaction to find that your Ideas agreed in Part with mine; but you say you cannot think with me, “ that “ there was a *general Dissolution* of the Earth “ at the Deluge, and that the immense Bodies of Rock that now exist, were ever in “ a fluid State, since they were first formed “ at the Creation.”

The Way to come at the Truth of what we have not seen, or don't know for certain, is to apply to Matters of Fact, Experiments, and the natural *Phenomena* of Nature.—On examining this Earth, in *all Parts* of the World, in *America* as well as *Europe*; *Asia*,
and

and *America*; from the Tops of the highest Mountains, to the deepest Places that have been dug in the Earth; we find it is composed of different *Strata*, as Sand, Gravel, Stone, Clay, &c.—In all *these Strata* are found *Exuviae* of Animals and Vegetables; particularly Sea Shells, in large Quantities.—Does not this prove, that these Shells, &c. *were mixed* with the Substance of the Stone and other *Strata*, when they were in a fluid State?

This could not happen at any Time, but at the general Deluge.—And (as was observed before) that, as they are to be found in great Part of the *Strata*, from the Tops of the highest Mountains, to the greatest Depths in the Earth; all must be dissolved.—The finding Skeletons of Elephants, and the Horns of the Mouse Deer, here in England, seems to prove that these *Strata*, wherein they are found, were in a State of Solution when these Relicks were there deposited; and also that the Deluge was universal.—How is it possible for a Flood of Water, many Feet deep,

deep, to be partial on any Part of the Earth ; it is well known that Water will give Way to Pressure, as may be observed by Pumps and Hydrostatic Machines, &c.—Therefore, as the Pressure of the Atmosphere is universally alike all over the Globe, (allowing for the Difference between the Heat at the Equator, and the Cold at each Pole) the Water must be forced equally round it.—This being the Case, we may reasonably suppose, that these Relicks must be brought from other Climates, to this Place ; neither one of them being an Inhabitant here.—Large Trees are also found in some of the Northern Latitudes, which are so cold as not to admit a Shrub to grow.

Moses, in his History of the Flood, as before observed, tells us, that God said, *I, even I*, do bring on a Flood of Waters on the Earth.—Hence we are informed, that it was brought on by *the immediate Act of God himself*, and *not according to the Agency of Nature.*

Nature.—Now though God brought it on *contrary* to that Agency, which he had established; yet he made Use of his material Agents, both to bring it on, and to carry it off.—Thus we find that Moses, in his History tells us, that the Method God ordered was *to break up the Fountains of the great Deep, and open the Windows of Heaven.* (g)

The literal Translation of the above Passage is, That all the Openings of the great Deep, through which the Fountains flowed, and the Holes and Cracks through which Air, Steam, or the internal *Expansion* or *Heaven* passed, were enlarged, spread abroad, and broke up.—Also that there was a very great Rain.—From all which it may not be improbable, but that the Shells, and different Parts of Animals and Vegetables, so found, were appointed as an undeniable Evidence, to the *latest Posterity*, that Moses's History of the Flood is true.

The Method made Use of was, (as he informs us) to increase the internal Expansion
and

(g) Gen. VII. 11.

and Rarefaction, so as to force out the Water from the Deep, through those Openings which became larger continually, and resisted less, as the Centre of *Gravity* was altered, by lessening the compressing Force without, and increasing the expansive Force within.— Thus the *Attraction of Cohesion* was taken away; hence the Parts of Stone, &c. became loose and easily dissolved, and were moved, and *by the Force of the Water below*, mixed with it and carried away.—The *Expansion* below continuing and increasing, till it had forced the Water fifteen Cubits upwards, above the highest Hills, which were covered and hid.

By this Description of the Agents, you may observe, that I agree with you in thinking, that there is a central Fire within this Globe, which I take to be the first Agent in all the Operations of Nature.—The late Earthquakes have shewed us something of its Effects, by which were thrown out hot Water, and burning Sand, &c.—Is it not probable that this central Fire may be made, by
God,

God, the Agent, which, at the last Day, may destroy this terraqueous Globe, with its Inhabitants?—Indeed this central Fire, which you mention, appears to be the cause of our Lakes and Springs, ^(h) both hot and cold.—Is it not probable that it assists to increase the Fertility of the Earth in some Places more than in others.—The Parts of Italy so much damaged by the late Earthquakes, as well as by former ones, are allowed to be some of the most fertile Places on Earth:—Can there be a Doubt but that Earthquakes are brought on by Steam arising from this central Fire. ⁽ⁱ⁾ It is observed, that after long continued Frosts, that the Thaw, generally, if not always, proceeds from below:—Do not these *Effluvia* from below, cause the Drains, &c. to swell before Rain? Has it not also an apparent Effect in sinking the Quicksilver of the Barometer, by its Force upwards, abating the Pressure of the Atmosphere? Without this, how will you account for the Difference of Cold under the same Latitudes, as *Newfoundland, Hudson's Bay,*

(h) See Letter. XVI. (i) Michel, on Earthquakes, Part 2.—Whithurst, C. XII

Bay, &c. which are in the same Latitude as England, and yet the Cold much more intense?—Unless you will suppose that the Shell of the Earth, under these Places in *America*, is thicker and closer than it is here in England, and thereby the Heat of the Fire and Steam below, are prevented from having so great an Effect on it.

I have now given you a short Narrative of my Theory of the Deluge, and how it was brought on.—Moses in his History gives but a short Relation about its going off, and the Reformation of the terraqueous Globe; which indeed he had no Occasion to do, as he had been so particular before in his History of the Creation and Formation of the antediluvian Earth; which I shall explain in my next Letter, as I have already run this to a great Length.—He only lets us know that God did not forget Noah, or suffer him to be destroyed, but that he caused a *Wind or gravitating Ether* to pass over the Earth, by which the Waters were assuaged, or as it is in the Hebrew, the Waters were *forced down*.

Adieu,

Stonehouse, Sept. 27, 1782.

F. PENROSE.

TO JOHN HEAVISIDE, Esq.

Original Names ideal.—The Reason why it has been asserted, and generally believed, that the Scriptures do not speak strictly true, with Regard to Philosophy, on the Motion of the Sun, Earth, &c. but is accommodated to vulgar Apprehensions.—The Mosaic Account of the Creation, and Formation, of this System; describing the Agents, which carry on the mechanical Operations of Nature; together with some Extracts from Sir Isaac Newton, to shew that he supposed the Agents of Nature to be the same as those revealed in the Scriptures.

DEAR SIR,

ACCORDING to the Promise in my last Letter, I have herewith sent you my Theory of the Creation and Formation of this terraqueous Globe.—The Instruction for doing it, I have taken from the Mosaic History, which Moses tells us came from *Jehovah* himself.—Indeed we have no other

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Account

Account of this grand Affair, therefore let us examine it with the same critical Strickness we would any other History.—If we find this History confirmed by all the Parts of the terraqueous Globe, and also by all the Phenomena of the Sun and Moon, &c. why shall we not believe it? *

It is agreed by the learned in general, and by Antiquarians in particular, that original Names, (in all Languages) were ideal, and gave an emblematical Representation of the Thing signified thereby.—Thus in Latin, *Candelabrum* signifies a Candlestick.—This Word is compounded of *Candela*, a Candle, and *Labrum*, a Cistern or Socket to contain a Candle; so that it was expressive, that this Instrument was to contain a Candle:—In English it is a *Candle-stick*, denoting that it was then made of a *Stick* or *Wood*, and not of Silver or other Metal as it is now.—We are informed by Moses, that the Names given by God, by Adam, by the Patriarchs, or by Himself,

* See Introduction.

Himself, were all *ideal*, and expressed the Reason why the Name was given.

Thus, when Moses asked the Lord, what he should say was his Name, ^(k) *God said unto Moses, I am, that I am; thou shalt say, I AM has sent me unto you; JeHoVaH.*—This is the incommunicable Name given by God himself; and though it contains but four Letters in the Hebrew, (the small Vowels being added to assist the Sound) yet it is so comprehensive and expressive, as to require a Sentence to explain it, which, with all Humility, I shall endeavour to do, viz. *The eternal self-existing Being, who was, and is, and is to come.*—Moses also informs us, that Adam called his Wife's Name HoVaH, *Eve*. This is a Participle passive, from HlāH *vixit*, to live, signifying *Life giving*, or, as we are told, because she was to be the Mother of all Living; or the Person from whom all Posterity were to derive their Being.—We also find, that God not only gave ideal Names, but also that he ordered those Names to be
changed

(k) Exod. III. 13, 14.

changed on particular Occasions, when the Alteration in Condition required it.—Thus *Abraham* from *Abram*, that is, from high Father, to the Father of a *great Multitude*, to express and be a Memorial of the Promise which God made him.—That *He should be the Father of many Nations*. ^(l) God also altered the Name of Jacob to Israel, &c. ^(m) If these Examples are not sufficient to satisfy any Inquirer, let him consult the Scripture Names at the End of *Cruden's Concordance*, and, I believe, he will want no more Examples?

For the above Reason, I shall give, (together with the Mosaic History of the Creation) a literal Translation of the Meaning of the Hebrew Words as they occur.—If it don't give you Instruction, I think it will add to your Amusement.—But before I do this, it will be proper to take Notice of a general Notion which has prevailed for about the three last Centuries, viz. That Moses, when he gives an Account of the Creation, Deluge, or Motions of the Heavenly Bodies, does

(l) Gen. XVII. 5.—(m) Gen. XXXII. 28.

does not speak philosophically true, *but accommodates himself to the vulgar Apprehensions of Men, to such Points of natural Philosophy as they were not able to comprehend.*

Now, in Answer to this, it is confest, in general, that there is a great deal of *Geography*, of authentic *History*, and *Chronology*, in the Bible.—Its History, its Chronology, or Philosophy, must be in Fact as true as its Theology; for to speak false in any Case whatsoever, or, if we suppose that any Part of the divine Word to be erroneous, it so far shakes the Authority of the rest.—If we believe his History of the Israelites to be true; why should we disbelieve his History of the Creation? especially if the Phenomena of the Sun and Moon, and all Nature confirm it.

Let us now enquire, why it was supposed that the Scriptures did not speak strictly true, with Regard to Philosophy.—By this Inquiry we shall find, that about Three Hundred Years ago, *Copernicus* published his Account

count of the Solar System, (which was no other than a Recovery of what was before maintained by *Pythagoras*, and other ancient Philosophers.)—For some Centuries before this, there had reigned an universal Ignorance, with Regard to the Sciences.—The Church, which was then that of Rome, had not, neither did they understand any other Scriptures but the vulgar Latin; which, according to their Apprehensions, asserted, that the Earth stood still, and that the Body of the Sun moved, rose, and set.—*Copernicus* and his Followers proved beyond Dispute, that it was not the Sun, but the Earth which moved. This being the Case, and these *learned Ecclesiasticks not being able to read and understand the original Hebrew*, (which spoke the contrary) were forced to give up the Cause, and to save Appearances, to cover their Ignorance, and to prevent farther Inquiry, they contrived to get it asserted, and preached from the Pulpit, that the Scriptures did not speak philosophically true, but that Moses did accommodate himself to the Apprehensions of the Vulgar.—Mankind being thus educated
and

and taught with their first Ideas, no Body seemed to doubt it. *

Moses, in the first Chapter of Genesis tells us, that the World was not *eternal*, but that in *the Beginning* God created the Heavens and the Earth.—After this he goes on to let us know, what Time God was forming it, and what material Agents he made use of for that Purpose.—He tells us that the Earth was created *without Form*, and had a *Void* or *Hollow* in the *Midst* of it.—That the Faces, (plural) or Outfides of it were covered with *Darkness*.—That the first Thing which God did, was for RUaCH, his Spirit, to cause a Motion, or Wind, or Pressure, amongst the Darkness on the Outside of the Waters.—The next Word, MeRaCHaPHeT, describing the Motion to be of the vibrating Kind, backwards and forwards, like the Waves of the Sea, pressed by Wind, or the Breath of an Animal, or the Hovering of a Hawk over his Prey; and God *said let there be Light*.—

Here

* Hence appears the Absurdity of Persons explaining written Laws they cannot read and understand.

Here it may be observed, that it was not a *new* Creation, but God said *let there be Light*; or let this expansive Struggle or Conflict continue till it produced Light—and there was Light; and God saw that the Light was good, or according to the Hebrew Signification, *that it was compleat*, and fit to answer all the Purposes it was designed for.—The Hebrew Name is AUR, a Particle passive from JAR, to flow like a River, to irradiate, to expand; as a Substantive a Splendor, an Irradiation, a continual Flowing or Motion.—Thus we find that the Name given to this Substance, (which was before called CHeSHeC, *Darkness*, Stillness, Inertness, Sluggishness) was of a quite different Quality to what it had been before, which was Stillness, Inertness; but this, a continual Flowing, like a River, *Motion itself*, or the moving Agent.—Hence it may be observed, that the Darkness which surrounded the terraqueous Globe, was divided into two Parts, viz. RUaCH, Spirit, Wind, or Air, in Motion, which caused Gravity and Compression, and AUR, Light, which gave Motion, and irradiated.

diated.—That God placed the Earth between the Light and Darknefs, fo that Light was on one Side of the Earth, and Darknefs on the other.—That God called the Air on that Side of the Globe which was covered with Light, JOM, *Day*, or *Tumult*, from the violent Agitation or Struggle there carried on between the two Parts, Light and Darknefs.—The State of the Air, on the opposite Side of the Earth, he called LaILaH, *Night*, *Inaſtivity*, *Laffitude*: Hence, on that Side of the Earth which was Day, there was a continual Struggle, or Conflict; and on the contrary Side, Night, or *Inaſtivity*.—That by cauſing the Globe to make a Rotation all round, there was Evening and Morning, or one Day.

On the ſecond Day we are told that God ſaid, “ Let there be a *Firmament* or *Expanſion* in the Miſt (*void*) of the Waters, and “ let that be an Inſtrument and Cauſe to divide between the Waters and the Waters.” Thus let the Motion between the Light and Darknefs increaſe, and by their Struggle and

U Conflict,

Conflict, cause an Expansion or Firmament; which Expansion, we are told, was the Instrument God made use of to separate or make to *gravitate* the earthy Parts from the Waters, and so form the Shell; which Shell of Earth when formed, separated and made a Division between the two Waters, viz. those on the Outside, under the outward Firmament, and these Waters on the Inside of the Shell, above the internal Expansion, in the *Midst* of the Waters.—After the Expansions between the Light and Darkness had begun to perform the Office they were designed for, God gave them new Names to denote their Office.—He now called them *Heavens*, ⁽ⁿ⁾ SHeMIM, that is the *Placers*, the *Disposers*, the *Agents*; also SHeCHeKIM the *Conflictors*.—These were God's Agents under him, whose Power he lets us know their Names represented.—Thus ended the second Day.*

(n) Psalm 89, 37.

On

* Saint Paul tells us, Rom. I. 20. *That the invisible Things of him from the Creation of the World, are clearly seen, being understood by the Things that are made, even his eternal Power and God-head.*

On the third Day the Action of the Expansion or Firmament, in the Midst of the Waters, still continuing and increasing by being surrounded and pent up within the
Shell

head.—In the Margin of our Bible, the Translators have referred us to the XIX Psalm, as the Place where the Scriptures have pointed out to us those Parts of *created Nature* which do it: I shall therefore give the first six Verses of that Psalm, which differ little from the English Translation, except being more literal.

Verse 1st. “The Heavens, as Books, represent to us, by
“their Numbers in Circulation, (a) the Glory of God; and the
“Firmament sheweth his handy Work, or his Strength and
“Power.”—(Thus, Job XXXVII, 18, we are told, that
“the Skies or Heavens are strong as a Molten Looking-Glass.)

2d. “Day unto Day causes his Decree to be spread abroad,
“and Night unto Night the Knowledge of Jehovah.*

3d. “Neither Words or Speech are in them; let their
Sound be attended to!”

4th. “Their Ordinance goes out over the whole Earth, and
“their Fulness (b) unto the End of the World.—The Place
“or Tabernacle for the solar Light (c) is spread out in them.

5th. “Which like a Bridegroom coming out of his
“Chamber,

Shell of Earth and Waters, *it burst the Shell,*
and got Vent, by which *the outward Waters,*
 (after the Rupture) were pressed down by the
 Firmament, to join those below, *within the*
Shell

"Chamber, and triumphs as a strong Man, (*like the great*
Man) to run a Course."

6th. "His going forth is from the End of the Heavens,
 "and his *Circuit* unto the Ends of it; and there is no *Thing*
 "nor *Place* hid from the Heat thereof."

Observations on the Words which differ from the English Trans-
lation.

(a) The Hebrew Word translated *declare*, is MeSePRIM, not a Verb, but a plural Noun, agreeing with SHeMIM, *Heavens*, and derived from SaPeR, which according to *Avenarius's Lexicon*, signifies "*numeravit ordine, recensit per Gyrum, et Circulum;*" to number according to Order, to declare, as in a Book, to number by a Circle.—As a Noun, a Book, a Numeration, a Scribe.

(b) MeLIHiM, translated Words are derived from MeLaH, which signifies *Fulness*, not Words. (*)—The Hebrew Words are DaGNoTH, JeHoVaH, which is literally the *Knowledge of Jehovah*; but in the English Translation it is, *sheweth Knowledge*.

(c) SHeMoSH in the English Translation is often rendered

Shell of the Earth, which was before occupied by the Expansion, and thus, as Moses informs us, the Waters were gathered to *one Place*; the Abyſs, but not to the Centre of the

dered Sun, as it is in this Place, though it never ſignifies the Body of the Sun throughout the whole Bible; but the Sun, Beams or Light proceeding from the Sun.—Whenever the ſolar Fire or Body of the Sun is mentioned in Scripture, it is called CHaMaH, and the Body of the Moon is called LIBNaH. Thus, Iſaiah XXX. 26.—“The Stream of Light of LIBNaH, *the Moon*, ſhall be as the Stream of Light of CHaMaH, *the Sun*, and the Stream of Light of CHaMaH ſhall be ſevenfold.”—The not making a proper Diſtinction between theſe two Hebrew Words, has been the Occaſion of great Confuſion, by attributing Motion to the Sun, and not to the Earth, (which is contrary to the Words of the Scriptures) and has given an Opportunity to the ſelf-ſufficient and conceited Deift, to ridicule them.—Thus in the Engliſh Tranſlation, the Sun is ſaid *to riſe* and *ſet*; but this is not found in the Hebrew; in thoſe Places it is SHeMoSH, the *Solar Light*, which is ſaid *to ſpring out*, and the *Solar Light* *to go off*.—Thus, *Joſhua*, X. 12. The SHeMoSH, the *Solar Light*, is ſaid to be ſilent, or not to go off, but to remain ſtill on Gibeon.—And IaReCH, the *Lunar*, or *reſlected Light* (this Word ſignifies *Effluvia*, *Odour*, or *reſlected Light*, from a Body, as *Canticles* II. 13—V. 10, and *1 Sam.* XXVI. 19, is the very ſame Word, of the ſame identical Letters, which in the Margin of the Engliſh Bible is tranſlated *Smell*) from the Moon, in the Valley of *Ajalon*.

Hence,

the Earth, which Place (I think with you) was and is always occupied by Fire.—Hence, as Moses informs us, by the going down of the Waters, the dry Land appeared.

I

Hence, we find, in this Miracle, that neither the Motion of the Sun, Moon, or Earth is mentioned, or at all concerned about it: It was only the *Solar Light* and the *Lunar Light* which remained in both those Places, till *Joshua* had destroyed his Enemies.—It was a supernatural Light that remained there! as a supernatural Darknefs had before remained in Egypt for three Days, (a *Darknefs that might be felt!*) whilst the Children of Israel had Light in their Dwellings, *Exod. X. 21, 22, 23.* Yet we have not the least Reason to suppose that the Earth stood still all this while.—We are told the contrary, that this Miracle of Darknefs remained three Days, or whilst the Earth made three Rotations round its Axis.—As the Earth did not remain still or stop her Motion, whilst this Miracle of Light and Darknefs was performed in Egypt, why should we suppose it did while a Miracle of the same Kind was performed on *Gibeon*? Had that been the Case, the whole solar System must have been disordered! which would have answered no End; it was as much a Miracle without it.—That it did not is evident from our Astronomical Calculations of Eclipses, Equinoxes, &c. for there is not one Minute of that Day deficient.

Thus we find that *SHeMoSH*, the solar Light, and *IaReCH*, the Lunar, or reflected Light, remained *still*, without Motion, in both these Places, in a miraculous Manner,
contrary

I shall now recapitulate what has been observed, from which it may be remarked, that this terraqueous Globe was created in a confused Mass or a *Chaos*; that it had a *Hollow* or *Void* in the Midst of it.—That this *Void* was filled with Darknefs, and the Outside of it was also covered with the same Substance.—That this Darknefs was *inert* or *inactive Matter*, which afterwards had different Names given it by God, expreffive of their Agency, till it was quite *good* or *compleat*, when it received the Name of *Heavens*, or the *Placers*, the *Agents*.—Thus God first caused a *Wind Weight*, or vibrating Motion or Agitation amongst the Darknefs, by which
Light

contrary to the Mechanifm of Nature.—But that CHaMaH, the solar Fire, or Body of the Sun, and LiBNaH, the Body of the Moon, were at the same Time in their Places in the Heavens; and that the Earth continued her usual Motions, and no Difference was occasioned on other Parts of the Globe, besides upon *Gibeon*, and in the Valley of *Ajalon*.—And Verfe 13 it is faid, that “ the SHeMoSH, the solar “ Light, remained in that *Part* of the Heavens, (viz. over “ *Gibeon*) it did not go off, (or *fet*) it was like an entire or “ perfect Day, and there was no Day like that before it or “ after it.”

Light sprung out, to which he gave the Name of *Light*, *Irradiation*, Splendor, or flowing *Motion*.——That the Globe had *Light*, Day or Tumult on one Side, and *Night*, a *Lassitude*, or a Decay of it, on the other Side.—That the terraqueous Globe was a Division between them.—That by one Rotation there was Evening and Morning on all Parts of the Globe, which made the first Day.—That on the second Day God caused an Expansion amongst the Darknes, in the Midst of the Globe; which Expansion caused a Separation of the earthy Parts from the Waters, and forced them outwards to join those which were pressed towards the Centre, by the outward Expansion, and thus a firm Shell of Earth was formed, which was a Division between the outward and the internal Waters.—On the third Day the internal Expansion continually increasing, and being confined by the Shell of Earth, it arrived to such a Strength as to burst the Shell, and get Vent; after that mixing with the outward Expansion, the Waters were pressed down into the Place lately occupied by it, by which Means

Means the Waters were in *one* Place, and the dry Land appeared; after they had performed this Action, God saw that they were good, or capable to perform the Agency he appointed for them; and he then gave them the Name of *Heavens*, the *Agents*, *Placers*; and deputed them to act.—And we find that they caused Vegetables, Trees, &c. to spring out of the Earth and grow.

Having now given you an Account of the Formation of this terraqueous Globe, as given by Moses, who tells us that the Earth now brought forth Vegetables, Trees, &c. I shall endeavour to explain how the natural Agents performed these Operations, which the Scriptures tell us they do; but before that, I take the Liberty to make some Extracts from *Sir Isaac Newton*, to shew that he supposed they did the same; and also that the *Phenomena* of *Projection* or *centrifugal* Force, together with the *Centripetal Gravity*, and all Kinds of Attractions are performed by the same Agents, *the HEAVENS*, the *ETHERS*; the Fluid which fills them.—This

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will

will be a Confirmation, that he has properly applied his geometrical and mathematical Demonstrations of these Effects, or *Phænomena*; which Demonstrations, I doubt not, will stand the Test of Ages, as *Euclid's* has already done.

Sir *Isaac Newton's* great Judgement and Skill in Geometry, was the principal Cause of excelling his contemporary Philosophers, for God *comprehended the Dust of the Earth in a Measure, and weighed the Mountains in Scales, and the Hills in a Ballance.* (o) Hence the most certain Method to ascertain the Truth of an astronomical or philosophical Hypothesis, is by Geometry, by Numbers, Weights, and Measure.—This was the Method that great Mathematician pursued his Studies; for in a Book of *Descartes*, which he made use of when at College, there still remain in many Places in the Margin, the following Remarks.—*Error, not geometrical.* But then great Care should be taken in their Application, not to apply them to improper Subjects,

(o) *Isaiah XL, 12.*

Subjects, for if applied improperly, we shall be mislead by them.—Sir Isaac himself has been guilty of this Error.—The Science of Geometry is derived from the System of Nature, which is a perfect *Automaton*, or a mechanical Machine, that has the Power of Moving within itself; but it was formed and set a going by the Creator, who saw that it was good, perfect, and compleat, and capable to perform all the Operations he designed it for, many of which are secret and wonderful.

Now let it be observed, that what Moses calls HEAVENS, or the *material Agents* under God, *Sir Isaac Newton* calls ETHERS, of which he gives the following Description.
 “ This Medium (says he) pervades all Bodies,
 “ and that there is *no Vacuum* but what
 “ it fills; that it readily pervades all Bodies,
 “ and by its elastic Force, is *expanded through*
 “ *the whole Heavens.* (p) And (q) that it is
 “ rarer within the Body of the Sun, than at
 “ its Surface; and rarer there than in the celestial

(p) Opt. P. 323.—(q) Opt. P. 325.

“lestial Spaces; so that if the elastic Force
“of this Medium be exceeding great, it may
“suffice to *impel* Bodies from the denser
“Parts of the Medium, towards the rarer,
“with all that Force or *Impulse* which we
“call GRAVITY.”—At the Conclusion of
his *Principia* he tells the same. (r) He farther
says, “We might add something concerning
“a certain most *subtile Spirit*, which *pervades*
“and lies *hid* in all Bodies; by the *Force*
“and *Action* of *which Spirit*, the Particles
“of Bodies mutually *attract* one another, at
“near Distances, and where, if contiguous,
“the elastic Bodies operate at greater Dis-
“tances, as well repelling as attracting the
“neighbouring Corpuscles, and Light is
“*emitted*, refracted, inflected, and heat Bo-
“dies; and all *Sensation* is excited, and the
“*Members of animal Bodies move at the Com-*
“*mand of the Will*, namely, by the Vibrati-
“ons of this *Spirit*, mutually propagated,
“along the solid Filaments of the Nerves,
“from the outward Organs of Sense, to the
“Brain, and from the Brain to the Muscles.”

Then

(r) Pemberton, P. 406.

Then in his Opticks, in Order to convey to us a Notion how this Agency was performed between the *Light proceeding* from the *Sun*, and the *Spirit* descending from the *Extremities*.—He has these Words. “The same
 “*great Weight* (or Spirit) may condense
 “those Vapours and Exhalations, as soon as
 “they shall at any Time begin to *ascend* from
 “the *Sun*, and make them presently fall
 “back *again into him*, and by that Action,
 “increase his Heat *much after the same Man-*
 “*ner* that in our Earth the Air *increases* the
 “*Heat of a culinary Fire*. (f) But, says he,
 “it is difficult to explain how Rays can be
 “alternately in Fits of easy Reflection, and
 “easy Transmiffion; unless perhaps one
 “might suppose, that there are in *all Space*,
 “TWO, (*Light* and *Spirit* as he mentions
 “before) ethereal, vibrating Mediums.”—
 Perhaps we may not get a more clear Description of the Agency of Nature than the above, from *Sir Isaac Newton*; the Truth of which all the *Phenomena* of Nature confirm, as well as the Scriptures; hence I shall
 take

(f) Opt. P. 339.

take the Liberty of adopting his two Agents, *Light* and *Spirit*; and, note, that whenever I make Use of either, I may be understood to mean the same by them, as has been above described from Sir *Isaac Newton*.

Having now extended my Letter to a Length, that I think, will tire your Patience, and the next Thing coming on to be explained being Vegetation, which will require another long Letter, I shall now conclude this, with a Promise that you shall receive another in a few Days.

I am,

DEAR SIR,

Your Friend,

And humble Servant,

F. PENROSE.

STONEHOUSE,
Oct. 4, 1783.

TO JOHN HEAVISIDE, ESQ.

Vegetation when it first began:—The Agents which carry it on described; together with the Method Nature makes use of for that Purpose.—The Vegetation of a Seed and Bud. Experiments from Dr. Hales, to ascertain the Effects of Heat and Cold on that Operation of Nature.

DEAR SIR,

MY last Letter I finished with the Waters being gathered together in one Place, and the dry Land appeared; and God said, let the Earth bring forth Grass, the Herb yielding Seed, and the Fruit Tree yielding Fruit after his Kind, whose Seed is in itself, upon the Earth: and it was so. And God saw that they were good.—On this the third Day ended,

It may be observed, that God, on the first Day, caused a *Splendor*, an *Irradiation*, amongst the Darkneſs, which covered the
Faces

Faces or Surfaces of the Waters. These *Sir Isaac Newton* observes, were the Agents, (which we find *afterwards* God called Heavens) to which he gives the Name Ethers, and filled all the celestial Space from the Sun to Saturn, and beyond.—These Agents, by their continual Conflict, caused an Expansion, and formed the terraqueous Globe.—Thus the Light by entering, opens and expands—and the Spirit, by pressing, forces every Thing closer together.—We are now told, that these Agents had a free Access to the Surface of the Earth, which by their Agency brought forth Grass; the Herb yielding Seed, &c. whose Seed was in itself.—Thus we find that Vegetation was the first Operation these Agents produced, after the forming of the terraqueous Globe.—And, perhaps, it is the *first in Dignity* that we shall be capable to understand—therefore, as it must be allowed, that the *Phenomena* produced by Nature, are much more *certain* and *less equivocal*, than what are obtained from Experiments of our own devising; so I shall endeavour to explain, in the best Manner I can,

“ and all Fire were taken away, all Nature
 “ would grow into one concrete Body, *solid*
 “ *as Gold, and hard as Diamond.*—But, up-
 “ on the Application of Fire, it would re-
 “ *cover its former Mobility.*—Consequently
 “ every Diminution of Fire is attended with
 “ a proportionable Diminution of Motion,
 “ and *Vice Versa.*”—Now, as we have the
 Authority of *Sir Isaac Newton* and *Boerhaave*,
 to affirm that the Heavenly Spaces, and all
 Matter, are filled with an ethereal Fluid,
 which acts in two Capacities, viz. by *Light* or
Heat entering their Parts, and expanding
 them, and by *Spirit* or *Cold compressing and*
forcing them together; we shall endeavour to
 trace out the Method Nature makes use of to
 cause Vegetation from a Seed to a perfect
 Plant or Tree.

Every Year, nay every Day, Experience
 confirms us, that *Heat* and *Cold*, which are
 the *Signs* of *Light* and *Spirit*, are the operat-
 ing Causes of Vegetation.—Thus, on the
 coming on of Winter, as the Heat of the
 Sun decreases, Vegetation languishes in Pro-
 portion

portion as he withdraws his Warmth.— Thus, if the Autumn proves warm, Vegetation is carried on with greater Vigour, and longer, than when, on the contrary, cold prevails.—And in the greatest Cold, in our Winter, it is quite stop'd and at a Stand; and thus it continues, till by the Increase of Heat in the Spring, the vegetable Juices are again put into Motion, when Seeds, Plants, and Trees begin to vegetate.—Therefore, in Order to explain this Operation, I shall take the following Method.—1st I shall examine, after a Seed is put into the Ground, what are the Causes which make it vegetate, and to become a Plant :—2^{dly}, what are the Causes, when Spring comes on, that make Plants and Trees to vegetate, and push forth their Buds and Leaves; and 3^{dly}, when Summer advances, what occasions Trees to grow, to bring forth their Fruits and Seeds to Perfection.

Those Persons who have been most conversant with, and who have made the greatest Discoveries in microscopical Observations, assert,

assert, that every Herb and Tree bear their own proper Seed, after their Kind.—These, on being thrown into the Earth, which is of a proper Heat, Moisture, &c. spread forth their Roots, and receive from thence their Nourishment and Support.—That the Lineaments of the future Plants, of every particular Kind, are in the Seed itself.—So is the Form of every Shoot of a Tree in the Bud, before it is forced open, and made to grow by the natural Agents acting thereon. These Buds, on the coming on of the cold Weather in Autumn, are covered close, and defended therefrom, by a thick mucilaginous and gummy Juice, very observable in many Trees, especially the Horse Chestnut, Ash, &c. and those Trees which shed their Leaves first, and are latest in the Spring before they Shoot. This gummy Substance continues thereon, till the Warmth of the Spring, or *some artificial Heat*, dissolves it, and frees the Bud from this obstructing Matter.—The same Heat which dissolves the Gum, penetrates the Bark of the Tree, thins and makes fluid the Juices contained in the *vascular Series* of Vessels,

Vessels, between the Bark and the Wood, and expands them.—The Manner and Power of which may be understood by the Effect Warmth has on a Bottle of Ale, or other Liquor, which it expands with such Force, that unless it finds a Passage by the Mouth of the Bottle, or some other Way, it bursts the containing Bottles.—This expansive Force continually increasing by the fresh addition of Heat, enters the Bud; (a Passage being made through the Rind for that Purpose;) where the Resistance of the gummy Substance being taken away, it expands his Parts, and spreads open its Leaves.—When this is done, it becomes in a growing State; the Method of which will hereafter be explained; but before we do that, it will be proper to examine the Make and Form of the different Parts of a Plant or Tree which I shall now describe.

1st. There is a thin outer Rind. 2dly. The *inner Rind* much thicker than the former, though both these Rinds are in general but thin, and of a *reticular* Form, with a Series
of

of Vessels between them; all these expand and dilate as the Tree increases in Size.— Their Use seems to be for the same Purpose as the Skin of Animals, either to inhale or exhale, according to the Alterations of the Weather, and also to dilate for the Enlargement of the Tree.—The 3d is the *Blea*, of a *spongy Nature*; it is of a considerable Thickness, and Uniform in its Texture, composed of hexagenal Cells, which appear to be designed for Reservoirs, for containing the watery and nourishing Particles, absorbed from the Atmosphere, under which lie the 4th Substance, called the *vascular Series*.— Its Structure is extremely Simple, being a single Course of greenish Vessels, lodged between two Membranes.—These Vessels have a free Communication with the Wood and *Blea*.—Here are found the greatest Part of the Juices for the Support of the Plant or Tree, all these pass upwards or downwards, according as the Heat or Cold, Moistness or Dryness prevail.—Here the Weather has a great Influence, for as the Heat from the Sun gets Strength, in the Spring of the Year,

Year, it thins and expands the mucilaginous Juices here contained, and forces out the Bud. On the contrary, as the Cold of Winter advances, these Fluids are condensed, thickened, and become mucilaginous.—We come next to the 5th, the Wood, and 6th, to the pyramidal Vessels contained therein; these pyramidal Vessels are not continued Tubes, are seldom found many Inches long, (as may be observed in Oak, Elm, and Horse Chestnut, &c.) and resemble these in the Bones of Animals.—A new circular Ring of these Tubes are formed every Year; these which are formed in Summer, are larger than those formed in Winter.—These Rings of Tubes, facing the South, are also larger than those towards the North; so that most Trees are *elliptical* instead of round, with the most prominent Side towards the South.—A new Root, a new Branch, and a new Circle of Fibres are formed every Year: Thus it may be observed, that a Root or Branch of the last Year, has only one Circle of Fibres, whilst the other Roots and Branches, as well as the Trunk, have as many Circles as they
are

are Years Growth.—The Roots are pushed forward, and formed from a Substance, found at the Extremity of every fibrous Root, in Form of a spongy Nipple.—The 7th is the *Pith*.—Whatever Part of the Plant we examine, we find these *seven* and no more.—The Root, the ascending Stalk, and descending Fibre, are one and the same, and not three Substances.—The Fibres of the Root *are supposed to be simple, capillary, Tubes*; but, upon a minute Inspection, we discover them to consist of the same component Parts of the Plant.

The only Part remaining necessary to be described are the Leaves, which are found to be formed of a Number of Vessels, interwoven amongst each other, in a net-like Form, very much resembling the Anastomosis of the Blood Vessels in the Lungs of Animals, and appear to be of the same Use to Vegetables, that the Lungs are to Animals, viz. to throw off the superfluous Moisture; these have innumerable Openings, which answer both for the Discharge of the superfluous Moisture,

Moisture, and also for receiving the nutritious Particles from the Atmosphere.—The Leaves are formed by the expanding and unfolding the Buds: these Buds make a Perforation through the several Integuments, whereby an easy Passage is given for the expanding Sap, to enter, to enlarge, and unfold the Leaves, which are spread out thereby, and being full of Pores, the Heat from the Sun has an easy Passage through them, and thereby to enter their Fluids, and expand them, till they are *specifically lighter* than the surrounding Atmosphere, and are forced off by it.—These Pores also admit the descending Dew, when the Coldness of the Air is so far increased as to overpower the internal Heat of the Juices contained in the Plant.—Having given an anatomical Description of the different Parts of a Tree or Plant, if you desire any Thing farther on this Subject, I would advise you to consult *Malpighi* and *Grew*, or a more late Author, the ingenious Dr. *Hunter*.

In Order to prove my Theory on Vegetation, it may be thought necessary to produce

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duce some Experiments, as well as the *Phenomena* of Nature, to confirm it.—As I cannot make, or find any more fit for this Purpose, than these already made by Dr. Hales, who, (as will be allowed by all) was accurate in making, and faithful in relating them, and had no farther Intention to answer, but that Truth might appear; for the above Reasons I shall take the Liberty to transcribe some of them in his own Words.

Dr. Hales tells us, that in Order to be informed how far Heat and Cold answered the different Purposes of Vegetation, “ He
 “ made use of six Thermometers, the first of
 “ which was above Ground, in the open Air;
 “ the second two Inches under Ground, in a
 “ South Aspect, the other four at different
 “ Depths, till the sixth was two Feet under
 “ Ground; (he tells us) that he kept a
 “ Register of their Rise and Fall, during the
 “ Month of August, and observed, that in
 “ the greatest Noon-Tide Heat, the Spirit
 “ in that Thermometer, which was exposed
 “ to the Sun, was risen, since early in the
 “ Morning,

“ Morning, from 21 to 48 Degrees.—The
 “ second Thermometer, whose Ball was two
 “ Inches under Ground, was at 45 Degrees,
 “ and the 3d, 4th, and 5th Thermometers
 “ were gradually of less and less Degrees of
 “ Heat, as they were placed lower in the
 “ Ground, to the sixth Thermometer, which
 “ was two Feet under Ground, in which the
 “ Spirit was 31 Degrees high; the 5th and
 “ 6th Thermometers, kept nearly to the
 “ same Height both Night and Day, till to-
 “ wards the End of the Month; when, as
 “ the Days grew shorter and cooler, they
 “ then fell to 27 and 25 Degrees. (t)

“ When in the coldest Day in Winter,
 “ the Frost was so intense as to freeze the
 “ Surface of the stagnant Water, near an
 “ Inch thick; then the Spirit in the Ther-
 “ mometer, which was exposed to the open
 “ Air, was fallen four Degrees below the
 “ freezing Point; the Spirit of that Ball
 “ which was two Inches under Ground, was
 “ four Degrees above the freezing Point;
 “ the

(t) Hales's Staticks, Vol. I. Ex. XX.

“ the 3d, 4th, and 5th Thermometers were
 “ proportionally fallen, less and less, as they
 “ were deeper to the sixth Thermometer;
 “ which being two Feet under Ground, the
 “ Spirit was ten Degrees above the freezing
 “ Point.—In this State the Work of Vege-
 “ tation seemed to be at a stand, at least
 “ within the Reach of the Frost.—But when
 “ the Cold was so far relaxed, as to have the
 “ Spirit in the first Thermometer, but five
 “ Degrees above the freezing Point, the se-
 “ cond eight, and the sixth thirteen Degrees,
 “ though it was still very cold; yet this be-
 “ ing some Advance from Freezing towards
 “ *Warm*, and *there being consequently some*
 “ *Expansion in the Sap*, several Evergreens
 “ and hardy Plants grew.”

The above Experiments of Dr. Hales, on
 the six Thermometers, from that in the Air,
 to that which was two Feet under Ground,
 show us the different Degrees of Heat at the
 different Depths, and also the Manner in
 which they retained it.—It must also be re-
 membered, that Solids and Fluids acquire
 their

their Heat sooner, and retain it longer, in Proportion to their Density.—Thus, put a Piece of Metal in Water, and place it on the Fire; the Metal will be so hot as not to be touched, by the Time the Water is warm:—Also, if you sit near the Fire, with a Key in your Pocket, the Key will be hot, and your Cloths hardly warm.

The same Thing may be observed, where the Sun shines upon a Piece of Metal; this, in a strong Sun-shine, will be found to be much hotter than the surrounding Atmosphere.—The same Effect may be observed with Regard to Cold, as has been by Heat, viz. by exposing a Key to the *Cold Ether*, in a Frost, it will be found to acquire a Degree of Coldness, much exceeding that of the Atmosphere.—Hence, (as will be explained hereafter) as the Earth is 1500 Times denser than the Air, so it will be found, by that Means, to be very useful in carrying on Vegetation.

From the above Facts, I shall endeavour
to

to draw proper Conclusions : In Order to do this, I shall observe the different Changes a Vegetable undergoes, from the Seed to a perfect Plant.—For this Purpose I shall make Choice of a Kidney-Bean ; as in that, these different Changes, which the Seed undergoes, will be more perceivable than in some others.

By putting a Kidney-Bean into the Ground, and covering it with a proper Quantity of Mould, at a proper Season of the Year ; in a few Days, the warm ascending Vapour from the Earth enters its Pores, and forcibly expands the Lobes of the Bean :—This expanding Vapour, (from the make of the Bean,) is forced from these Lobes into the capillary Vessels of the Radicle, which, by continually receiving a fresh Supply, is forced out and elongated, which when extended to a certain Degree, resists more than the Power from above ; at this Time, still receiving additional Nourishment from the Earth, the expanded Seed Leaves are forced out of the Ground ; after this the *Plume* being uncovered, by the opening of the Lobes, the expansive

panfive Force opens and unfolds its Leaves, and when they are sufficiently enlarged, so as to throw off the superfluous Moisture, becomes a perfect Plant, an hydraulic Machine, *Sui Generis*, and wants no more Assistance from the Lobes, which now drop off as useless.

Having now, according to my Proposal, explained the Method whereby a Seed becomes a perfect Plant, and, as my Letter is already extended to a greater Length than, perhaps, you will like to read at one Time, I will leave the Consideration of the Means and Causes of its Growth and Support, to my next Letter, which you may expect to receive soon after this.

Adieu,

F. PENROSE.

STONEHOUSE,
Oct. 11, 1783.

TO JOHN HEAVISIDE, Esq.

Experiments from Dr. Hales, which prove that Vegetables inspire and expire according to the Dryness and Moisture, and the Heat and Coldness of the Air.—The Method Nature makes use of to perform Vegetation.—Trees and Vegetables grow in the Form of a Pyramid, unless prevented.—The Cause assigned why Plants in a Green-house, or other Room, point towards the Window.—The Juices of Vegetables always in Motion, but do not circulate like the Blood in Animals.—Some more Experiments from Dr. Hales, to explain the Method Nature makes use of in the Bleeding Season, (in the Spring of the Year) to force out the Buds and Leaves.

DEAR SIR,

I Finished my last Letter with the Account of the Progress of a Vegetable from a Seed to a perfect Plant ; and according to my Promise, I have sent you an Account of the
Methods

Methods Nature makes use for its future
Growth and Support.

Having received the greatest Information for doing it, from the Experiments of the judicious Dr. Hales, I shall now take the Liberty to make Use of some more of them, for confirming what I shall now send you.

The following Experiments were made in Order to observe the different Effects produced by the different Degrees of the Heat by Day, and the Cold by Night;—on the Growth of Vegetables; and also, the different Effects produced on them, by the different Changes of the Weather.—For this Purpose he planted a Cabbage and a Sunflower, each in a Pot, which he constantly weighed every Day, for a Month.—He found, “that some Days the Cabbage perspired, “when the Weather was hot and dry, more “than a Pound and Half.—That the Sunflower, in twelve Hours, of a very warm “Day, perspired one Pound and fourteen “Ounces; the middle Rate one Pound four
A a “ Ounces;

“ Ounces ;—The Perspiration of a warm, dry
 “ Night, without any sensible Dew, was a-
 “ bout three Ounces ; but when any sensible
 “ but small Dew, then the Perspiration was
 “ nothing.—When a large Dew, and some
 “ little Rain in the Night, it increased in
 “ the Weight two or three Ounces. ^(u)

From the above Experiments, it may be observed, that these Vegetables perspired more or less, according to the State of the Atmosphere which surrounded them, whether it was warm or cold, moist or dry ;—That they *perspired* most in a warm and dry Air ; on the contrary, in moist Weather, or a large Dew, they *inspired* very considerably from the Atmosphere, as their Increase of Weight demonstrates.

Hence it is clear, from the foregoing Experiments, that the Leaves of Plants are serviceable towards carrying on the Work of Vegetation, in bringing Nourishment from
 the

(u) Hales's Staticks, Vol. I. Exp. 1.

the lower Parts and Roots ;—Plenty of Dew is imbibed by them, by which Means they receive a great Part of their Food from the Atmosphere, which is always stocked with vegetable Nourishment.—Hence we find, that after the Plume of the Seed, and the Leaves are pushed out, they perspire or inspire, *according to the Heat, the Coldness, the Dryness, or Moistness* of the Air ; in the Day-Time, when the Air is hot and dry, it dilates, and expands their Pores, (more especially when the Sun shines) and rarefies their Juices, whereby it ascends in the Atmosphere ; thus a *Vacuum* is made, and Room is given, for the Sap ascending from the Roots !

The small fibrous Roots act the Part of *Syphons*, and the moist Vapour, ascending from the Earth, is absorbed or sucked in, by the Roots, faster or slower, more or less, in Proportion to the Number of Roots, and the Rarefaction of the Fluids in them ; for these Juices will *recede* and *accede* according to the Heat and Rarefaction, or Cold and Compression, till an Equilibrium is formed :—When
that

that happens to be the Case, and every Pore and Vesicle is filled, then the Moisture, Dew, or Rain will remain on the Leaves, in the same Manner as it may be observed to do on oiled Paper, when every Pore of the Paper is filled with Oil.—This may often be observed in a growing Season, in the Morning, in the Spring of the Year.

Thus, so long as the Heat proceeding from the Sun, is powerful enough to rarefy the Juices, in the Leaves of the Plant, to a sufficient Degree, they continue to perspire the superfluous Juices, ascending from the Roots, and what they send up, as regularly continue to supply the Place of those perspired; unless (as it sometimes happens) in a hot and sultry Day, that there is more Moisture perspired by the Leaves, than the Roots can sufficiently supply, during that Time.—When this happens to be the Case, we observe the Leaves of the Plant to flag, and to continue in that State till the Coldness and Moistness of the Air is so far increased as to prevent the Heat from rarefying more Juices than can be supplied in the same Time from the Roots.

As the Heat of the Sun goes off in the Evening, and the Air becomes colder, and loaded with Dew, the Perspiration of the Leaves abates, till the Coldness and Denseness of the Atmosphere, together with the descending Dew, fill up the Pores of the Leaves, stop the Motion of the Sap upwards, and by its Increase of Gravity, makes the Sap to descend towards the Roots, and carry with it from the Dew, such nutritious Particles of the Atmosphere, as it may contain : thus it finds its Way to the most capillary Roots, forces out the Sap that Way, and elongates them !

The Difference of Density between the Earth and the surrounding Atmosphere, adds greatly to the Growth or Elongation of the Roots of Trees and Vegetables : The Earth being so much denser than the Atmosphere, it retains the Heat, it receives from the Sun, a considerable Time longer ; neither is it subject to the sudden and great Changes often occasioned in the Atmosphere ; indeed some little below the Surface (as was proved by
the

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the

the Thermometers) it retains the same Heat great Part of the Summer, Night and Day.

It is the Nature of Trees and Vegetables, (if their Growth is not prevented by other Trees or Vegetables standing too near them) to take the Form of a Pyramid; the lowest lateral Branches being longer than those immediately above; and, as the Tree advances, the lateral Branches succeed in first, second, and third Order, &c.—Thus they continue to grow in this Manner, unless the Rarefaction and Perspiration of these lateral Branches are prevented by others growing too near them, as may be observed to be the Case in thick Woods, Groves, Corn, and other Vegetables, which stand so thick and close to each other, as to shade and hinder the Expansion and Condensation by the Heat and Air, and of Consequence the Perspiration of the lateral Branches.—When this happens to be the Case, the Rarefaction and Perspiration can only be carried on in the upper Part of the Tree or Plant:—Hence, by the Sap being perspired from the top Branches only, the

the Tree is enlarged in no other Part, and grows in Height only; thus, by the Perspiration being carried on no where but the Top, most, if not all, the lateral Branches, perish for want of Perspiration, and of Consequence Nutrition.— Hence, the Reason why Trees grow upwards, for the Sun-Beams descend in straight Lines to the Earth, and enter the Tree at its Top, whereby the greatest Rarefaction will be there, and the Juices in the Tree, ascending from the Root, will be forced thereto, and the Branches will there be enlarged and lengthened; but when Plants stand single, or at a proper Distance, and surrounded with a Freedom of Air, the lateral Branches grow in a just Proportion to the Top, as *the Atmosphere, and all Fluids, press equally every Way.*

Hence also is the Reason why Plants, in a Room or House, where there is but one Window, (especially if that Window faces the South;)—the Plants placed therein will always grow towards the Window, where the Sun-Beams and Light enter: Thus,
Plants

Plants which perspire very plentifully, as the Sun-flower, may be observed in Height of the growing Season, to follow the Sun, with their Tops pointing to him; in the Morning they bend towards the East, at Noon South, and in the Evening towards the West.—By the same Cause, Trees or Plants, near a Wall, always grow from it, pointing towards the Sun; nay if a Plant is placed in such a Situation, that no Sun-Beams are sent on it, its Growth will tend to the Place from whence the Light proceeds

Thus, during the Summer Season, when there is Heat enough to make Vegetables grow, their Juices are in continual Motion, as well as the Blood in Animals, but with this Difference; that the Blood in Animals undergoes a continual Circulation, but the Motion of the Sap in Vegetables, is only from their Roots, through their whole Substance, where, at particular Places, the *plastick* Make of those Parts absorbs and retains such Portions of the nutritious Juices, as are proper for their Support and Increase.—Thus it
may

may be observed, particularly in a Grain of Wheat, which puts forth three different Successions of Roots, for the different Periods of its Growth; first, after putting a Grain of Wheat in the Ground, three Fibres are shot from the Radicle; upon the Wheat spearing, fresh Fibres are struck out; soon after they are established, the three first Fibres, with their Branches, gradually decay.—As soon as it comes in Ear, fresh Fibres make their Appearance, soon after which the second decay. The above Account of these *three* Sorts of Roots, made by *culmiferous* Plants, are given us by the ingenious Dr. Cullen, who tells us it was a Discovery of *Bennet's*, and are termed by him, the *Infancy*, the *Adolescence*, and *Maturity* of the Plant.

Now let the Unbeliever, who makes an *Idol* of his own Understanding, meditate on the Power given by God, to a Vegetable, to enable every Part thereof to cull and appropriate such Parts only, of the nutritious Juices they receive, as are fitted for the Growth and Support of these only, whether it be for Leaves,

B b

Roots,

Roots, Stalks, Flowers, or Seeds.— If he cannot understand the Actions of this *simple Machine*, let it humble his Pride so far as not to be Wise above what is revealed!

Having explained the Method Nature makes Use of to cause the Vegetation and Growth of Plants, I shall now, as I proposed, endeavour to explain the Means whereby Trees push forth their Buds, Leaves, Fruit, and Seeds.—In Order to do this, I shall again take the Liberty to make use of some more of Dr. *Hales's* Experiments, which he made on Vines, to ascertain the Strength of the Expansion of the Sap, at the Bleeding Season, in the Spring of the Year.—“ April 6th, “ at nine, A. M. Rain the Evening before, “ he cut off a Vine, on a Southern Aspect, “ two Feet nine Inches from the Ground; “ the remaining Stem had no lateral Branches; “ he fixed on it a mercurial Gage.—At 11, “ A. M. the Mercury was risen 15 Inches.— “ at 4, P. M. it was sunk an Inch.” (v)

“ April 7th, at 8, A. M. risen very little,

“ a

(v) *Hales's Staticks*, Vol. I. Exper. XXXVI.

“ a Fog:—At 11, A. M. 17 Inches high,
“ the Fog gone.”

“ April 10th, at 7, A. M. Mercury 18 Inches high; he then added more Mercury, so as to make the Surface 23 Inches high: *The Sap retreated a little into the Stem, upon this additional Weight, which shews with what an absolute Force it advances.*—At Noon it was sunk one Inch.”

“ April 11th, at 7, A. M. $24\frac{3}{4}$ Inches high, Sun-shine.—At 7, P. M. 18 Inches high.”

“ April 14th, at 7, A. M. $20\frac{1}{4}$ Inches high; at 9, A. M. $22\frac{1}{2}$ fine warm Sun-shine.—*Here we see that the warm Morning Sun gives a fresh Vigour to the Sap.*—At 11, A. M. the same Day, $16\frac{1}{2}$ —*The great Perspiration of the Stem makes it sink.*”

“ April 16th, at 6, A. M. $19\frac{1}{2}$ Rain.—At 4, P. M. 13 Inches.”—Though it had sunk since Morning, he found by Exp. 34.
that

that it had risen since Noon two Inches.—*This Difference he says was occasioned, in the first, by the Perspiration of the Sap.*—The other Stem being so very short, there was little Room for it.”

“ April 17th, at 11, A. M. $24\frac{1}{4}$ high, Rain and Warm; at 7, P. M. $29\frac{1}{2}$ fine warm rainy Weather, *which made the Sap rise all Day, there being little Perspiration by Reason of the Rain.*”

“ April 18th, at 7, A. M. $32\frac{1}{2}$ Inches high, *and would have risen higher, if there had been more Mercury in the Gage.*—From this Time, to May the 5th, the Force gradually decreased.—The greatest Height of the Mercury being $32\frac{1}{2}$ Inches, *the Force of the Sap was equal to 36 Feet, $5\frac{1}{4}$ Inches Height of Water.*

“ Here the Force of the rising Sap in the Morning, is plainly owing to the Energy (*of the Sap*) in the Root and Stem.—In another mercurial Gage, (fixed under the Bottom

toma

tom of the Vine, which ran twenty Feet high) the Mercury was raised by the Force of the Sap, 38 Inches, equal to 43 Feet, 3 Inches $\frac{1}{2}$ of Water.—As the greatest Height the Atmosphere will rise Water is thirty-two Feet, so this Force was about *one Third greater* than the Pressure of the Atmosphere.”

Dr. Hales tells us “That the Mercury constantly subsided in a Gage, fixed on a Branch of a large old Vine, by the Retreat of the Sap, about nine or ten in the Morning, when the Sun was hot; but in a moist, foggy Morning, the Sap was later before it retreated, viz. till Noon, or some Time after the Fog was gone.”—About four or five o’Clock, P. M. when the Sun went off the Vine, the Sap began to push afresh into the Gages, but it always rose fastest from the Sun Rise, till nine or ten in the Morning.—The Sap on the Branch of a large old Vine played the most freely to and fro, and was therefore soonest affected with the Changes from hot to cold, or from wet to dry, and

Vice

Vice versa."^(w)—He observes that the great Force, exerted by the Branch of this large old Vine, "was not from the Root only, but must also proceed from some Power in the Stem and Branches."—After the Leaves are pushed out, no Trees will then bleed, neither have they any Force to push out their Sap; *all* is then perspired by the Leaves.—"Moisture and Warmth made the Sap most "vigorous, Ex. 38, but the Vigour of the "Sap would immediately be greatly abated "by cold Easterly Winds." ^(x)

"If, in the Morning, while the Sap is in a rising State, there was a cold Wind, with a Mixture of Sun-shine and Cloud; when the Sun was clouded, the Sap would immediately subside, at the Rate of an Inch in a Minute, for several Inches, if the Sun continued so long clouded: But as soon as the Sun-Beams broke out again, it would immediately return to its then rising State, just as any Liquor in a *Thermometer* rises and falls with the Alternacies of Heat and Cold; whence, says he, it is probable, that the plentiful

^(w) Hales's Exp. XXXVI.—^(x) Exp. XXXVIII.

plentiful Rise of the Sap, in the Vine, in the Bleeding Season, is effected in the same Manner.—When, says he, three Tubes were fixed at the same Time to Vines on an *eastern*, a *southern*, and *western* Aspect, round my Porch, the Sap would begin to rise in the Morning, first in the eastern Tube, next in the southern, and last in the western Tube: and towards Noon it would accordingly begin to subside, first in the eastern Tube, next in the southern, and last in the western Tube.”

“ Rain and Warmth, after cold and dry, would make the Sap rise all the next Day, without subsiding, though it would rise then slowest about Noon.—The Sap begins to rise sooner in the Morning, in cool Weather, than after hot Days.”

“ When at the Distance of four or five Days, Tubes were fixed to two different Branches, which came from the same Stem, the Sap would rise highest in that which was last fixed; yet, if in the fixing the second

Tube,

Tube, there was much Sap lost, the Sap would subside in the first Tube."

" In very hot Weather, many Air-bubbles would rise, so as to make a Froth an Inch deep, on the Top of the Sap in the Tube."

" But when towards the latter End of *April*, the Spring advances, and many young Shoots are come forth, and the Surface of the Vine is greatly increased and enlarged by the Expansion of the several Leaves, whereby the Perspiration is much increased, and the Sap more plentifully exhausted, it then ceases to flow in a visible Manner, till the Return of the following Spring."

" And as in the Vine, so is the Case the same in all the bleeding Trees, which cease Bleeding as soon as the young Leaves begin to expand enough to perspire plentifully, and to draw off the redundant Sap.

Exp. 44, " Since by other Experiments it
is

is found, that the greatest Part of the Sap is raised by the Warmth of the Sun on the Leaves, which seem to be made broad and thin for that Purpose; for the same Reason it is probable, it should rise also, in those Parts which are most exposed to the Sun, as the Bark is." — "It is found that the Trunk and Branches of Vines were always in an imbibing State, *caused by the great Perspiration of the Leaves, except in the Bleeding Season.*" (u)

Therefore to prove the great Power Seeds receive, (when sown) from the expansive Power of a warm Vapour — Dr. Hales put some Peas into an Iron Pot, with some Water, and then fixed on it a Cover, and on that 184 Pounds Weight, which the dilating Peas lifted up; he also found they would lift up any Weight that was not sufficient to press them together. (w) "We see, says he, by this "Experiment, the vast Force with which "swelling Peas expand; and 'tis doubtless "the same Force which is exerted, not only "in *pushing* the Plume upwards into the Air,

C c

" but

(u) Hales's Staticks, Vol. I. Exp. XLVI.— (v) Vol. I. Exp. XXXII

“ but also in enabling the first Shooting of
 “ the Radicle of the Pea, and all its subse-
 “ quent tender Fibres, to penetrate and shoot
 “ into the Earth.”

Having now given the Experiments I pro-
 posed, with Regard to Vegetation, with some
 Observations thereon, in my next Letter, I
 shall endeavour to explain that Operation in
 as short and easy a Manner as I can.

Adieu,

F. PENROSE.

STONEHOUSE,
 Oct. 18, 1783.

To

TO JOHN HEAVISIDE. Esq.

A Recapitulation of the Method Nature makes use of to carry on Vegetation. —The natural Agents hot and cold Ether. —Fire and Motion synonymous. —The Phenomenon of Vegetation a proper one to explain the Agency of Nature. —The Cause why Trees shed their Leaves in Autumn; and the Means made use of to push forth their Buds and Leaves in the Spring. —The Scripture Account of Vegetation perfectly agreeable with Nature. Cold and hot Ether, the Agents which support and carry on Animal as well as vegetable Life.

DEAR SIR,

IN my three former Letters, I described the Agents, and the Method Nature made Use of to carry on Vegetation, which were long, and which, I imagine, you thought tedious, on Account of the many Phenomena and Experiments there related, to prove that
what

what I said was confirmed by Nature.—I shall now, in Order that you may have a more clear Perception of it, recapitulate that natural Operation in as short and clear a Manner as I can.

A Recapitulation of what has been observed.

In the first Place I shewed from Sir Isaac Newton's own Words, that he supposed there was an *ethereal Fluid*, which filled the *Pores of all Bodies*; and also that this Fluid filled all Space, from the Sun to the Orb of Saturn, and beyond.

Secondly, That this Fluid acted in *two* Conditions, one of which he called *Light* or Heat, and the other *Spirit* or Cold.—That these two were in continual Circulation and *Struggle*, from the Sun to the Extremities of the System.—The Light or Heat, ascending from the Sun, *opening and expanding*; and, the Spirit descending to the Sun, *contracting and compressing* every Thing.—After this I gave *Boerhaave's* Account of what were the Agents Nature made Use of
in

in her Operations, which was "That Fire
 " or Motion were *synonimous*," for, says he,
 " let an Iron Bar be heated, it increases in
 " all its Dimensions, and the more so as it is
 " farther and farther heated; but on being
 " exposed to the *Cold*, it contracts, and its
 " Parts are forcibly pressed together, and re-
 " turn through all the Degrees of Dilatation,
 " till it comes to its first Bulk, or to the
 " same Degree of Heat which it had when
 " the additional one was applied, being never
 " two Minutes of the same Dimensions.—
 " Hence, says he, if there were the greatest
 " Cold, and all Fire were taken away, all
 " Nature would grow into one concreate
 " Body, *solid as Gold*, and *hard as a Diamond*.
 " But upon the Application of Fire it would
 " recover its former Mobility."

Finding that these two great Philosophers,
 as well all the Ancients, attributed the first
 Agent in Nature to be Fire; and that all
 Nature were filled with an Ether, which
 acted in two Qualities, viz. Light and Heat,
 or Spirit and Cold; and imagining that the
Phenomina

Phenomena produced by natural Operations, were more simple, expressive, and less equivocal than Experiments produced by Art; I endeavoured to find one that would answer our Purpose; accordingly, that of Vegetation appeared to be most likely to do it.—Therefore I examined the Observations and the Explanations of different Philosophers thereon; and found little Assistance from any but the ingenious Dr. Hales, who, from a Set of well chosen Experiments, accurately performed, and faithfully related, hath cleared this simple Operation from its Intricacy.

By which it appears, that a Seed is covered with an outward Shell, which is of such a close Contexture, as to prevent the common Atmosphere from entering.

The Seed, by being put into the warm Ground, is acted upon by the *warm Vapour*, which is continually ascending into the outward Atmosphere.—The *Light* or *Heat* of this active Vapour enters the outward Shell, penetrates and expands the Lobes of the
Seed

Seed (which Lobes answer the same Purpose to Seeds, that the *Placentia* does to Animals) expands and enlarges them; from hence, by the *plastick* Make of the Seed, it is forced into the Radicle, which it also extends and elongates, and pushes into the Mould, and by being continually acted upon in the above Manner, it continually increases, till by its Number of Fibres, it receives a greater expansive Force, by the warm Vapour it receives from below, than what is supplied by the Lobes, which now burst the inclosing Shell, and by this Force, from below, are impelled above Ground, when the *Lobes* separate, and the *Plume* appears, which is now enlarged, and its Leaves spread abroad, and becomes a perfect Plant, and the Lobes or *Secondines* drop off as useless.

A Plant and a Tree are hydraulick Machines, and are supported and made to grow by the two Agents *Light* or *Heat*, and *Spirit* or *Cold*.—As either one of these act upon the Parts of the Plant or Tree, so does its Growth and Increase go on.—A Tree is composed of a
Root

Root which is in the Ground, a Trunk above the Ground, and Branches which are spread in the Air, answering to the Roots below.—Now it is found by Experience, that you may pull up a young Tree by its Roots, plant the Boughs or Branches in the Ground, and let its Roots spread in the open Air, as its Boughs used to do, it will grow in this Form, push out Leaves, Blossoms, Fruit, and Seed.—The Leaves are formed wide, thin, and full of Pores, and answer the same Purpose to Plants, that the Lungs do to Animals, to perspire the superfluous Vapour sent up from the Roots.—Thus, in warm Weather, when the Sun shines on the Leaves, the Light or Sun-Beams enters their Pores, expands their Juices, and as soon as they are specifically lighter than the Atmosphere, are forced off by it.—Hence a *Vacuum* is there formed, which is immediately filled up and supplied by fresh Vapour ascending through the Tree or Plant, from the Roots.—In this Manner the Juices received by the Roots, are carried throughout the whole Plant or Tree; and, after it has
collected

collected such a Portion of it as is fit for the Support of every Part, the superfluous Moisture is perspired by the Leaves :—This continues all the Day, till the Heat of the Sun-Beams begin to decline in the Evening, and the Cold increases.—Thus, as that comes on, the Cold condenses some of the Moisture in the Atmosphere, and presses it down towards the Earth, as the Heat goes off.—The cold, moist Air and Spirit enter the open Pores of the Leaves, and as they overpower the Heat, force the Juices through the whole Substance of the Plant, down to its smallest Roots, which they force out and elongate.—In this Manner the Plant grows and increases in Bulk, till the Cold is so very powerful, to contract or press the Juices into a *Concreate*, when all Vegetation ceases, and the Leaves drop off as useless.

Thus, as the Cold of Autumn comes on, the Juices of the Tree are inspissated, the Buds and outer Rind are covered with a gummy Substance, in the same Manner as is used to cover the Silk of a Balloon, to pre-

vent the common Air from having any access within.—As soon as this is done, the Trees which are used to shed their Leaves, drop them off as useless, and continue in a torpid State till the next Spring.—In April, the Sun-Beams have sufficient Power to enter the Bark of the Tree, which then expand its Juices, and make them fluid; and, by the continual Increase it receives every Day, it acquires a Force one third greater than the Pressure of the Atmosphere.—The Wood of the Tree being of a closer Nature, and resisting more than the Rind, the Juices are made to expand in the *Series* of Vessels between the Bark and the Wood, which communicates through every Part of the Tree, and particularly with the Buds, which have Openings made for that Purpose, through all the Integuments of the Bark, &c. where this expansive Force enters, develops the Buds, and forces out the Leaves; and when they are quite expanded, the Tree becomes a perfect hydraulick Machine, as was before described, and grows, and is supported as above.—Thus, as soon as the Leaves are pushed forth, the
expansive

expansive Force of the Juices is gone, the Tree will no longer bleed, but inspires or expires, and thereby keeps up a continual Motion of the Juices, till they are concreted by the coming on of the Winter cold.

Having explained the Operation of Vegetation, which Moses tells us was performed on the third Day, by the natural Agents already found to be good, and capable to do the Office God assigned to them.—He now put them into Action, and by this Expression, *let the Earth bring forth Grass*, gave them Power to do it.—*Thus ended the third Day, or the third Revolution of the Earth.*

It gives me Satisfaction to find, that the Method and Agency of Vegetation above described, are represented to be the same in the Scriptures, and that in this Instance they speak philosophically true: For Moses informs us, ^(w) that Vegetables could not grow, till the Earth was supplied with Water or Rain, and that they were made to grow by a moist

(w) Gen. II. 5, 6.

moist ascending Vapour, which watered the whole Face or Surface of the Ground; and that *to those who hearkened to the Voice of the Lord, he will open his good Treasure, the Heavens, to give Rain to the Land, in his Season, and to bless all the Work of their Hands;* (x) and Job informs us, that Vegetables are nourished and supported by Earth and Water; and the Agents which perform this Operation, are the solar Light and Heat of the Day, and the Dew and Moon Shine; for, says he, *can the Rush grow without Mire or Mould? can the Flag grow without Water?* (y) Thus Moses, in his Blessings on the Tribes of Israel, tells the Tribe of Joseph, *that the Blessings shall be on their Land, for the precious Things of Heaven, for the Dew, for the precious Fruits brought forth by the solar Light, and for the precious Things put forth by the lunar Light;* (z) and in Samuel we are informed, that *the tender Grass springeth out of the Earth, by clear shining after Rain.* (1) And Job tells us, that *though the*
Root

(x) Deut. XXVIII, 12.—(y) Job. VIII, 11.—(z) Deut. XXXIII, 12, 13.
 (1) 2 Samuel XXXIII, 4.

Root of a Tree wax old in the Earth, and the Stock thereof die in the Ground, yet there is Hope, if it be cut down, that it will sprout out again, and by the Scent of Water or Vapour, issuing from the Earth, it will bud and bring forth Boughs like a Plant. ⁽²⁾

It may be remarked, that Animal Life is carried on and supported by the same Agents which carry on and Support the Vegetable, viz. *Light or Heat, and Spirit or Cold.*

Some Years ago I had the Honour of being acquainted with a Lady of Fortune, who lived in a large House, but did not keep a great deal of Company; she had a large Parlour which was made but little Use of.—In October I was shewn a Bat, who had taken up his Winter Lodgings on one of the Cornices.—I saw him many Times afterwards, between that and Christmas, when he appeared Motionless, as if dead.—At Christmas I persuaded the Lady to have a Fire in the Room, to see if it would procure Life to the Bat.

⁽²⁾ Job. XIV. 7, 8, 9.

Bat.—She accordingly agreed that we should spend one Day in that Room, and have a large Fire therein.—Some Time after Dinner, when we did not think of it, we were entertained with the Flight of the Bat, who flew round the Room with great Life and Vigour.—But we found, the next Day, after a cold Night, that he was returned again to a torpid State.—The same Thing may be observed by bringing Flies into the Warmth any Time in the Winter; but what puts this beyond Doubt is, the hatching of Chickens in Stoves.—The Egg, like the Seed of Vegetables, is covered with a Shell, and these Eggs may be preserved in their present State, a long Time, if prevented from having only a proper Degree of Heat; but put them under a Hen, or in a Stove, of a proper Temperature, in three Weeks a Chicken will be produced, who will then break the Shell, live, breathe, and feed, and be so far a compleat Animal as to feed itself.

On the 4th Day we are informed, that God made two great Instruments of Light, and
placed

placed them in the Firmament of Heaven, to regulate or rule the Day and the Night; that they were to divide between the Day and the Night—and that they were to be the *identical Instruments*, to point out and divide the Seasons, the Days, and the Years.—Thus it may be observed, that on this fourth Day, the Motion of the Heavenly Bodies began, and was carried on by the natural Agents; for God tells us, that he saw that they were good, and *capable to perform the Offices assigned to them*.—Here then, (as it is natural he should,) Moses begins his Chronology. ⁽³⁾—The first four Days, till the Sun and Moon were formed, the Rotation of the terraqueous Globe was under the immediate Direction of God; but, now it was an *Automaton*, under his deputed material Agents, the Sun, (the Moon, the Stars, and the Heavens,) unless he thought proper, at any Time, by a Miracle, to stop or to alter their Agency, and so to convince skeptical and unbelieving Men.

I am, dear Sir, with the greatest Sincerity,

Your obliged Friend,

F. PENROSE.

STONEHOUSE,

Oct. 25, 1783.

(3) Introduction, P. 5.

TO F. PENROSE, ESQ.

Mr. Heavyside professes a great Inclination for the Study of natural Philosophy, though he had been prevented from attending to it so much as he wished.—He then puts the following Quere.—In that general Dissolution of Substances, which you suppose at the Deluge, why were not Shells, Bones, Shrubs, &c. dissolved, as well as Rocks, Stones, &c.

DEAR SIR,

I Cannot but take Shame to myself, at Sight of the Dates of the Letters you favoured me with, which I am sorry to say is above three Months ago; more especially as they were such as I felt, and still feel myself so much obliged to you for.

The only Apology I have to make, (and I wish I had not had it to make) is, that I was not well during the whole Autumn.—I was first seized with a Disorder in my Bowels,
(the

(the first I ever had) which continued three Weeks, and left a low Fever upon me, which continued as many Months. — I, however, kept on Foot all the Time, but very uncomfortably; till being quite weary of so long and disagreeable a Visitor, I determined to take a Ramble, and try to lose him, which I put in Execution, and with Success: For having rambled, for three Weeks, thro' the North of England, I returned Home very much better, and have been very well, thank God, for above a Month past; though, perhaps the constant Hurry I have lived in, during that Time, may have contributed not a little, to keep me well.

I employ this, my first Hour of Leisure, to acknowledge and thank you for the Trouble you have been so good as to give yourself, to explain your Ideas of the Causes of those Appearances we now see on this terraqueous Ball. — But pray do not imagine, that because I have not made it so much my Study to have, that therefore I take no Pleasure in Natural Philosophy, or that I am so easily

E e

tired

tired of the Subject, as not to wish for the Sentiments of so ingenious and well-informed a Searcher into Nature, as you are.—Far otherwise; for though I have been debarred of proper Opportunities of Information, and my Habits of Life have been such, as to prevent me from any close Application to Study, yet I have always felt a Propensity to know and account for the Phenomena of Nature, and the Causes of those various Appearances, which every Moment, and every where, strike the Eye of the least attentive Observer.

But as my Inlets to Knowledge have been few, very few indeed, compared to yours, it would be extreme Folly in me to contend *seriously* with you on this Subject; and therefore would wish you to look on what I object to your System, as rather designed to draw out *Information*, than to produce *Conviction*. In this Light, give me Leave to ask you, why, in that general Dissolution of Substances, which you suppose to have taken Place at the Deluge, those Shells, Bones, Shrubs, &c. that are undoubtedly found (as
you

you say) in all Parts of the World, both on the Summits of Mountains, and in the Depths of the Earth; *why were not those Substances dissolved likewise?* And what Reason can be given, why the Cause, (whatever it was) that could dissolve Rocks, and Marble, should not dissolve those Substances which are of so much looser a Contexture? This is a Question which has just now occurred to me, on looking into the Beginning of your Letters; and I must confess, it seems to me as rather favourable to my Hypothesis than yours.—I shall therefore be much obliged to you for your Thoughts upon it; and as my present Leisure will not allow me to enter further into your Theory, at this Time, I shall beg Leave to defer my further Consideration of it, till my Hurry is a little over, when I shall, with your Permission, trouble you with what further Remarks may occur to me upon it.

I am,

DEAR SIR,

Your very obedient,

And faithful Servant,

PRINCE'S-STREET,

J. HEAVISIDE.

Sunday, Jan. 11, 1784.

TO JOHN HEAVISIDE. Esq.

Prejudices of Education hard to be overcome, therefore many Things in Mr. Penrose's Theory may appear doubtful at first, as they differ from some which are generally taught: There may be Arcana in Nature, which human Reason may not be able to explain.—Answer to Mr. Heaviside's last Query.—A Constitution and Custom observed by the Royal Society, concerning Disquisitions.—The Waters the Outside of this terraqueous Globe, not sufficient for the Flood.—Centre of Gravity altered at the Flood.—Causes assigned why Bones, Shells, &c. were not dissolved.

DEAR SIR,

YOUR Mind being prepossessed with *Ideas* very different from many Things in my Theory, I doubt not but some will *stick* with you, *at first*, (whatever they may do afterwards) I am sure they did so with me; but as neither you or I are any further concerned

cerned than for the Amusement of ourselves, and the Investigation of Truth; so we shall be more likely to agree about them, than the generality of Disputants; whose Endeavours are often to explain the Truth away; and I trust, we shall be both ready to embrace it, let it be found by either of us.

In Order to get at *Truth*, we ought to suspect our own preconceived Opinions, to divest ourselves as much as may be from our Prejudices, and make use of the greatest Impartiality in Judgement; for we must observe, how greatly all People are *biased* to the *Ideas* which have been ingrafted on their *Understanding*, by *Education and Custom*; notwithstanding some of them may be the greatest Absurdities.—Thus, for Instance, we find many of the Wives of the Indian Kings are brought to believe, that by Self Murder, (*a Crime which we think the greatest, and most contrary to Nature!*) they shall inherit the greatest Blifs.—Under this Persuasion, many throw themselves into the Funeral Pile with their dead Husbands; encouraged and animated

mated to it, by those who are believed to be the best and wisest of their People.— We may also observe, that a Person educated in Italy, will be a Catholick; in England, a Protestant; in Turkey, a Mahometan; in India, a Gentoo.— *Errors*, from the same Cause, reign in Philosophy as well as Divinity; our philosophical Opinions are generally formed in the same Manner, *from Education, and the Company we keep*; and often under the Protection of some great Name, whose Notions few dare to oppose, or even to investigate or examine. — Thus the Earth, Moon, and Planets were believed to circulate round the Sun, by the Ancients, down to *Pythagoras*.—After that the *Ptolemean* System took Place, then the *Tychonic*, and now the ancient System is again recovered by *Copernicus*, and his Followers, and demonstrated to be true by the *immortal Newton*, and believed by nearly All.

The above Observations shew us how easily we are made to believe false Opinions by Education, and with what Difficulty they
are

are eradicated afterwards.—A great many of them are often believed to be innate, and implanted in our Mind by God.—Hence, in Matters of Consequence, we should not receive *implicitly* those Opinions we have been taught, or are generally believed as true, *without Examination*; wherever this is the Case, it must be a great Obstacle to Improvements in Arts and Sciences.—For the above Reasons, though I may observe some Things which are contrary to your preconceived Ideas, or to general received Opinions, or what you may have been taught to be true; yet, I hope, from your known Impartiality, you will not discard them without Examination.

You have chosen a Question, the Answer to which will assist to elucidate my Theory, and I hope my Explanation of it may prove satisfactory to you; although, as you observe, it has a contradictory Appearance.—“ Why
 “ in that general Diffolution of Substances,
 “ which you suppose to have taken Place at
 “ the Deluge, those Shells, Bones, Shrubs,
 “ &c. that are undoubtedly found (as you
 “ (say

“ say) in all Parts of the World, both on
“ the Summits of Mountains, and in the
“ Depths of the Earth; why were not these
“ Substances dissolved, and what Reason can
“ be given, why the Cause (whatever it was)
“ that could dissolve Rocks and Marble,
“ should not dissolve these Substances which
“ are of a much looser Contexture ?”

In the first Place, I shall beg Leave to observe, that though the whole Operations of Nature are ALL carried on in a *mechanical Manner*, yet there may be some *Arcana* which may be out of human Power to explain.—But it is the Duty of every Searcher after Truth, not to evade the Question.—But if he cannot explain it, to confess it.—I hope, from what follows, that you will think, that I do not make the above Observation with a Desire to get rid of your *Query*, but only to lay in my Claim, lest I should want it hereafter.—However, you shall find that I will answer quite to the Point in Question, without Evasion.

I shall

I shall now pursue the same Method I did in my former Letter, first giving the historical Account of the Event, and then prove it to be true from Facts or Observations.

It may be observed, that Moses, in giving us the Account of the Flood, (which in Fact is the only one we have, or can have) tells us, that God said “*I, even I*, do bring a “Flood of Waters upon the Earth.”—According to this Account, it was a *Miracle*, performed by God himself, by altering the Operations of Nature; but yet performed by material Agents, in a *mechanical* Manner.—Had it not been performed by material Agents, it could not be Evidence to our Senses, neither could we understand it, whilst our whole Machine, by which we receive our Ideas, is material.

In Order to explain these seeming Contradictions, I shall observe the Method directed by the Royal Society.—“The Constitution and Custom of which are, that “every Disquisition must either terminate in

“ a mathematical Demonstration, or be form-
“ ed upon some one or more Experiments,
“ Observations, or Histories of Facts, for a
“ Foundation of Reasoning, and the Con-
“ clusions drawn, must necessarily appear to
“ flow from the Premises; and the Danger
“ of drawing general Conclusions in natural
“ Philosophy, and Physical Disquisitions, lies
“ not in Arguments, *a Posteriori*, from the
“ Effect to the Cause; but in the *hypothetick*
“ Way, that is, by Parity or Similitude; to
“ Parity and Similitude of Effects, which
“ must be often a fallacious Method, and the
“ Source of many Errors; for this same
“ Cause, acting by one and the same Power,
“ according to the same Laws, is often made
“ to produce not only different, but even
“ contrary Effects, according to the specifick
“ Differences of the Subjects acted upon.—
“ Thus Heat makes Clay hard, but softens
“ and melts Wax, Metals, &c.”—The Case
before us is another Instance of the same
Kind.

Here we have two Facts open to our View,
(besides

(besides a Number of others of the same Original) viz. the hardest Rocks shew us, that they were in a State of Solution, when the Shells, Bones, &c. were mixed with their very Substance; on the contrary, that these Shells, Wood, and Parts of Vegetables, are almost in a perfect State, though of a much looser Contexture.

I believe all Philosophers, who have wrote on the Flood, have allowed, that there was not a sufficient Quantity of Water on the Outside of this Globe, to cover it a tenth Part so high above it, as we are told the Waters prevailed.—If this is so, and the Fact is true, we must search some other Place for it? none will be found but within the Bowels of this Earth; accordingly Moses tells us, that this Flood was brought on “by the breaking up the “Fountains of the great Deep, and opening “the Windows of Heaven.”—(Or, as it is expressed in the Original) opening the Cracks and Chinks, whereby Air passes through the Earth.—That Steam or Vapour is continually passing through them, is at this Time observed by Miners. It

It appears, before this *Phenomenon* could succeed, that the Centre of GRAVITY (let it be a Power inherent in *Solids* or *ab extra*) and the Attraction of Cohesion must be altered.—Let us suppose (for suppose it we must, as we are not informed of it) that God by his own Act, (I even I, says Jehovah) altered the Place of the Centre of Gravity, from within the Earth, to such a Distance on the Outside; the Consequence would be as Moses has told us it was.—The Waters would flow outwards by all the Fountains, Openings, and Chinks of the Earth, Rocks, &c. (the Number of which will be more easily conceived by viewing our Cliffs of Marble, than can be described) which would make no Resistance (Gravity being altered) but would be dissolved and carried away by the Impetuosity of the Efflux, and with many other Bodies, make one common *Colluvies*.

It may be observed in this common Destruction, that Earth, Rocks, Stone, &c. (which were kept or bound together by *Gravity* or *Attraction of Cohesion*,) on the Alteration

ation of the Centre of Gravity, and the Efflux, caused thereby, of the Waters, must be reduced, if not quite, *nearly* to their smallest Parts.—On the contrary, Shells, Bones, Shrubs, Leaves, &c. which are not held together by Gravity, or Attraction of Cohesion, but by Fibres, Sinews, Tubes, Membranes, &c. tied, twisted, and complicated together in a wonderful Manner, would not be affected by it; the Attraction of Gravity would not untwist their Fibres, therefore those Parts of Animals and Vegetables, notwithstanding their soft Texture, would remain as before.

After the Waters had prevailed God's appointed Time, Moses tells us that God remembered Noah, and would not suffer him to be destroyed, which he must have been, had the Waters not assuaged.—God, by his own immediate Act, by *his Spirit*, or what may be called Ether, (this is the same Word as translated Spirit, Gen. 12.) restored the Power of Gravity to the Place appointed to

it

it before the Flood; and the terraqueous Globe was again restored to its pristine Form. (4)

From what has been observed, the following Conclusion seems naturally to arise, that Gravity was the Agent which forced off the Waters.—If so, is Gravity a material Power? If it is, does it lie in Solids or Fluids?—No great Difficulty seems to be in giving an Answer to the above Questions!

Farewell, my dear Friend, till I write you again, which I will do soon.;

F. PENROSE.

STONEHOUSE,
Feb. 2, 1785.

(4) See Let. I. III.

TO JOHN HEAVISIDE, ESQ.

As the first material Agents cannot come within the Knowledge of our Senses, so different Philosophers have formed different Opinions. But Astronomy may be proved by mathematical Demonstration.—History is no more than a Romance without Chronology; which is not certain, unless proved by Astronomy.—Where to begin our Astronomical Epoch.—Moses's Account of the Place of the Sun and Moon at the Creation, proved by Mathematical Demonstration.—First Meridian proved by an Observation of Dr. Bradley's.—As Mr. Penrose is not fearful of being convicted of Error, Leave is given to Mr. Heaviside to shew this Letter to any Proficient in Astronomy, and get their Criticisms on it.

DEAR SIR,

I Thank you for your Present of the Book, on the Deluge, which I have read already—It is coming down in Betsey's Box,
on

on board the *Rose*; when it arrives, I shall give it another Reading, and doubt not but I shall receive Satisfaction from some Parts of it; and I shall, (which I assure you I always do) *endeavour* to divest myself of all preconceived Ideas.—As the first material Agents, have not, neither ever can they come under the Examination and Knowledge of our Senses; so different Sects of Philosophers have formed different Hypotheses about them, which has been the Cause of such a Variety of Opinions.—For some Years past, my principal Study has been Astronomy.—A most sublime Science! The *Phenomena* of which may be proved from *mathematical Demonstration*; but even this Proof will be of no Signification to those who have *preconceived* Principles of a different Nature, and are thereby *prevented from examining* whether they be true or not.—There is another Thing against my Notions in Astronomy; it requires some Attention to understand them; therefore few will be proper Judges of them; some of them are contrary to the general preconceived Opinions, and as popular Prejudices are difficult to be overcome,

come, so these Notions of mine will be opposed.—This Study is certainly of great Use; for History is no more than a Romance, without Chronology, and there can be no Certainty in Chronology, unless proved by Astronomy: Indeed without some fixed and astronomical *Era*, to which historical Narrations may be referred, however true in themselves, they will be deemed very little preferable to Romance. — Tho' I have heretofore troubled you with some of my Notions on Philosophical Subjects, which, perhaps, you may have thought both a Waste of Time and Trouble to read over; yet, you see I am so fond of scribbling, that I cannot help perplexing you with a brief Account of some of my astronomical Ideas.

In the first Place, I must agree with *Keil*, who says, “ As in the Heavens there are certain Points, from which Astronomers begin their Computations of the Planets Motions, so also there must be certain Points, or Instants of Time, from which, as from Roots, all Calculations must begin;

G g

“ and

“ and all memorable Actions are disposed and
 ‘ recorded, according to the Series of Years
 “ which follows from that Root. These
 “ Roots are called *Epochs* or Eras, from
 “ which we generally count our Years or
 Times.” ⁽⁵⁾

The Beginning of Time may be considered as an *indivisible Instant*; but Time is a *determinate successive Duration*, measured by Motion; so that Motion and Time are cœtaneous. If we trace it back to the first Moment, it must be the Instant before planetary Motions had any Existence, or were Nothing; and when planetary Motions shall cease, then cometh the End of Time.

If we know any thing when planetary Motion or Time began, (as most Historians pretend to,) it must be discovered, either by Observation or Calculation, or be revealed from God. But as there was no human Witness to the Creation, it could not be discovered by Observation, neither could it be discovered
 by

(5) Introduction, Page 7.

by Calculation : But Moses has revealed it ; and I have certainly the Liberty to take Moses's Account as true, if I hereafter prove, from Mathematical Demonstration, that it is so.

Hence I begin my Epoch of Astronomy, on the fourth Day of the Creation, when, Moses tells us, the Sun and Moon were formed and placed in the Heavens, *to point out Times and Seasons, Days and Years.* — Here then we have one *Datum* or Root, viz. the fourth Day of the Week, twelve o'Clock, (which it must be on the Place in which the Sun was in the Meridian.) *Josephus* tells us, the Jews reckoned their Years by the Sun, and their Months and Days by the Moon. Moses also orders the Israelites (least they should be at a Loss when to begin their Days) to keep their Sabbaths from Evening to Evening.⁽⁶⁾ Hence we find that the Chronology of Time began, on the fourth Day, *at Evening*, which was the Day after the Moon's Opposition, or when she was full; when they
(viz.

(6) Levit. XXIII, 32.

(viz. the Sun and Moon) enlightened the whole Earth, as Moses tells us. — That the Israelites, and their Posterity, might not be at a Loss to know the Time of the Year, and also the Distance of the Moon from the Sun, Moses instituted the Feast of Ingathering, (*after they had gleaned up their Olive and Vineyards*) to be kept in Remembrance of that great Event. — This Feast was to be kept on the 15th Day of the Moon (as it is in the Hebrew) or Month, in the *End* or *Revolution* of the (*Solar*) Year.⁽⁷⁾ As every Month was begun on the Evening of the Visibility of the Moon, so this 15th Day must be just after she was past the full. The Jews keep their Feasts of Tabernacles and Ingathering in this Manner, to this Day; and, according to their Tradition, it is in Commemoration of the Creation of the World, which happened at this Season; viz. at the autumnal Equinox, the Sun in *Libra*, at the full of the Moon. To be short.⁽⁸⁾

I shall now assume the following *Data*, and
prove,

(7) Exodus, XXIII, 16 — Deut. XV, 13. — (8) Introduction, Page 6.

prove, by Mathematical Demonstration, that they are true. Viz. 1st, that the Sun was formed on the fourth Day of the Week, at the Creation, at twelve o'Clock, in the first Meridian, at the Autumnal Equinox, or the Sun in Libra, the Moon 15 Days past the Conjunction, the Day after the Opposition.

Secondly.—That according to the Mosaic Account, A. D. 1753, is in Connection with A. M. 5760, and Time is measured, positively and absolutely, by the Rotation of the Earth round its Axis, or a natural Day; and its annual Revolution thro' the Ecliptic. If, therefore, I prove that A. D. 1753, is the same identical Year with A. M. 5760, it must be mathematical Demonstration that the above Assumptions are true. Now, ⁽⁹⁾

A. D. 1753, we know to be the same Year as 6466, according to the Julian Period. I substract Moses's Account of the Age of the World, 5760, from 6466 of the Julian Period, there remains 706, in Coincidence with
the

(9) Introduction, Page 25.

the Year of the Creation. — The Julian Year is 11 Minutes longer than the Solar tropical Year, by which Means the Equinox fell back 44 Days, and, according to the Julian Kalendar, from Oct. 25, to Sep. 22, N. S.

Multiply 5760 the Number of annual Revolutions, or Solar Years.
By 1461 the Number of Rotations
of the Earth round its
5760 Axis, or natural Days in a
34560 Quadriennium.
23040
5760

Divide by the Years } 4) 8415360 (2103840 Days in 5760
in a Quadriennium. } Julian Years.
Days of Retrocession in 5760 Julian Years, 44 to be subſtrct.

Sun in Libra, A.D. 1753, A.M. 5760, 2103796 A.I.P. 6466,
true Solar Days.

To know the Day of the Week, add 4
the extra Days before the Sun and
Moon meaſured Time.

Divide by 7) 2103800 (300542 Weeks
ſince the Creation, or in 5760 (6) Saturday.
Solar Years.

T A B L E.

A. I. P. 706. Sun in Libra. Firſt Meridian	Interval. 5760 Years. 2103796 Days.	A. I. P. 6466. Sun in Libra. Firſt Meridian.
D. H. M. Oct. 25. 00. 00.		D. H. M. Sep. 22. 00. 00.

By

By a very accurate Observation, Dr. Bradley observed that the Sun entered Libra A.D. 1753, September 22, on a *Saturday*. This had not happened before, since the Creation, neither can it happen again, on the *same* Hour and Minute, and Day of the Week, for many Thousand Years to come; therefore 1753 must be in Connection with A. M. 5760; this proves it to be as mathematically certain, that the Year, Day, Hour, and Minute, and Day of the Week, happened at the the Time when Moses tells us it did, as it is to measure the Distance from Hatfield to London, by a Wheel: For Here are two Points, viz. Hatfield and London; by running a Wheel from Hatfield to London, you will know how many Rotations the Wheel makes, between Hatfield and London: So here you have two Points, viz. the Autumnal Equinox, A. I. P. 706, or the Year of the Creation, and the Autumnal Equinox, A. I. P. 6466, in which Time the Earth performed 5760 annual Revolutions, and 2103796 Rotations round its Axis, which measured the Interval, and united the two
Points

Points together. — Hence we have mathematical Demonstration that Moses's Chronology is true; and also, we have an *Epoch* whereon to begin our astronomical Enquiries. — The above is trifling Evidence, to what may be brought by the Astronomy of the Sun and Moon, by all the *Eclipses, Equinoxes, Solstices, new, and full Moons*, which have happened since the Creation.

I am not very fearful to be convicted of Error, in what I have said above, therefore (as perhaps you may meet with *Adepts* in Astronomy) I shall have no Objection to your shewing them what I have said; and, as Truth is the Object sought, I should be glad to hear their Criticisms on it.

I am,

DEAR SIR,

Your obliged Friend,

And Servant,

F. PENROSE.

STONEHOUSE,

Wednesday, Feb. 9, 1785.

TO F. PENROSE, ESQ.

Mr. Heavyside having shewed Mr. Penrose's Letter to some eminent Astronomers, Members of the Royal Society; they "all agreed "that his Calculations were perfectly right, "and proved what He intended they should; "and that they would have desired Leave to "have read the Paper at the Meeting of the "Royal Society; but that it was deemed to "be connected with religious Subjects, which "they never meddle with there." Queries to Mr. Penrose, occasioned by the aforesaid Letter.

DEAR SIR,

I AM highly obliged to you for your kind Letter, and for being so good as to state to me the Proofs of the Truth of the Mosaical History of the Creation: They are certainly very learned and ingenious; I have read them with great Pleasure, and have only to lament my own Ignorance, in not being able (for

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want of more Science in Astronomical Matters) to fully comprehend their Force. As you have always been so good as to make Allowance for my Ignorance on any Philosophical Subjects, and hear, without Offence, my Objections to some of your Opinions; so, I hope, you will pardon me for asking you a few Questions, not in the Way of *Objections*, but merely for Explanations, that I may the better comprehend the Whole of your Theory; which, I presume, is this, viz. that according to Moses's Account of the Creation, and the Number of Years he makes it from thence to the Flood; added to the Years from the Flood to the coming of our Saviour; and from thence to the Year 1753 of our *Æra*, making up the Number 5760, the true and real Age of the World, is thereby fully ascertained, and Moses's History proved to be a true one of the Creation *at that Time*.

You have proved, from Dr. Bradley's Observation, that the Whole Planetary System was in the exact Position, in the Year of our Lord 1753, that they were, and must necessarily

family have been at the Creation; and that they had not, nor could have been in the like Situation for 5760 Years before; nor will, probably, be so again, for as many to come. I shall therefore call this 5760th Year, the Year of the great *Cycle* of the Universe: But whether I call it properly so, or not, I do not know; nor does it much signify, if you will give me Leave to use it as a Term, by which you may understand my Meaning. Now I would ask what Proofs can be adduced, that the same Cycle, or Number of Revolutions, may not have happened over and over again, before Moses's Date of the Creation.

I must also beg you to explain the Use of your Table, and why in the one is Oct. 25, and in the other Sept. 22. I subjoin the Table as I copy it from yours.

T A B L E.

A. I. P. 706. Sun in Libra. First Meridian	Interval. 5760 Years. 2103796 Days.	A. I. P. 6466. Sun in Libra. First Meridian.
D. H. M. Oct. 25. 00. 00.		D. H. M. Sep. 22. 00. 00.

I know that I expose my Ignorance in asking this; but I am not ashamed of doing that to you, who already know it so well.

The above I wrote (as what occurred to me on the first attentive Perusal of your Scheme) as soon as I had read it; and, having your Permission, I afterwards copied it, and shewed it to two or three of my Friends, whom I thought better acquainted with Astronomy than myself.

One of these I knew to be intimate with an eminent Astronomer, of the Royal Society; and, as I wished, he asked my Leave to shew it to him, which I readily gave him. He called on me a few Days ago, and told me that that Gentleman was much pleased with it, and had kept it till now, that he might shew it to his Astronomical Friends of the Society; and that they *all* agreed that your Calculation was *perfectly right*, and *proved* what you intended it should do: But, at the same Time, they made the same Observation upon it that I had done, viz. that it did
not

not prove that there had not been previous Revolutions (or Cycles, as *I* call it) to that mentioned above. You will not wonder that *I* was both surprized and pleased, to find that *I*, who am *un-learned* in such Subjects, should thus have *blundered* upon what had struck all these *learned Men*.

I must add, that the Astronomical Gentleman would have desired Leave to read the Paper at the Meeting of the Royal Society; but that it was deemed to be connected with *religious* Subjects, which they never meddle with there.

I find you will, in Time, give me an Itch for Philosophizing likewise, which hitherto I have only amused myself with now and then, as it has fallen in my Way. As a Proof of this, I have lately often thought of our Conversation at Hatfield, wherein you explained Sir Isaac Newton's Assumption of the inexplicable Terms of Gravitation and Attraction, and in their Place, affirmed that Fire, or Heat, answered all the Purposes equally, and
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was a Substance, or Quality, known and allowed by all. As we had not then Leisure to develop the Whole of your Ideas on that Subject, I should esteem it a great Favour if you would be so kind as to give me a general View of your Opinions upon it, whenever you have Leisure, and find Inclination to gratify me with it.

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PAINCE'S-STREET,
March 20, 1785.

TO JOHN HEAVISIDE. ESQ.

Moses's History of the Creation ought to be examined by Chronology and Astronomy, which is the true Test of all History. — The Cycle of Years explained; — Answer to Mr. Heaviside's last Queries; — Ether the Cause of Gravitation; — Gravity and Levity relative Terms. — The Agency of the Ethers explained; — they are the Cause of Winds, Hurricanes, Earthquakes, &c. — they alter or destroy Attraction, Gravitation, Cohesion, &c. Is the Cause of the different Motions of the Earth, and its spheroidal Shape; the Cause of Tides, &c.

DEAR SIR,

I Thank you for your last Letter, which (by informing me, that what I had written to you had received the Approbation of some eminent Astronomers, Members of the Royal Society) gave me great Pleasure, as their Approbation does me a great Honour than

than ever I expected to receive.—So learned a Body of Men (by the Discouragement they have given to Guess, Speculation, and Hypothesis) have been the Means of those distinguished Improvements, which the Sciences have received: It being one of their Constitutions to admit Nothing *but what must terminate in Mathematical Demonstration, or what is founded on Facts, and Reasonings and Calculations which necessarily flow from them.*—I think we should pay the *same* Regard to Moses's Account of the Creation, as we would do to any other Historian.—For, as I observed in my last Letter, History, if not proved by Chronology, is no more than a Romance; and there can be no Certainty in Chronology, unless proved by Astronomy.—On the Contrary, History and Chronology, which is proved by the Situation of the Sun and Moon, at the Time these Events happened, and confirmed by Eclipses, when the Moon intersects the Earth's Orbit; together with her Oppositions and Conjunctions, &c. must be as true as that there is a Sun and Moon; for their Conjunctions and Oppositions

tions will occur, at their appointed Seasons, as long as Time shall last. — Thus we know, by Calculation, that *Ptolemy's* Account of the most ancient Eclipse of the Moon to be true; as we find, by Calculation, it must have happened, at the Time He mentions, either at Alexandria or Babylon: — I would try Moses's Account of the Creation in the same Manner.

The Gentlemen you shewed my Scheme to, as well as you, very justly observe, that the Exactness of it depended upon a *Cycle* of Years, and tho' my Calculations were perfectly right, *yet they did not prove but that there might have been many Cycles before the Time mentioned by Moses.* — In Regard to the Time of the Creation; it must have been known, (if known at all,) either, 1st from Observation, or, 2ndly, it must be proved by Calculation; or, 3dly, it must be revealed. — It could not be observed, as there was *then* no Human Person to observe it; neither could it be found out by Calculation: But Moses informs us it was revealed, and to confirm his

Account, has given us the Situation of the Sun and Moon, and Day of the Week, at that Minute of Time.—*These are Facts!* and I think it cannot be imagined that Moses (who wrote at a Time when Astronomy was little known) should be able to calculate the exact Place of the Sun and Moon, at the particular Instant of Time of that Event, which he tells us happened more than Two Thousand Years before he was born.—I therefore, think that if, on Calculation, we find that his Astronomical Account be true, we ought to allow his Fidelity, as an Historian, to be confirmed.

In order to find the Cycle of Years,

Multiply 525949 the Minutary Measure of a Solar
tropical Year,
Into 5760 the given Number of Solar tropical Years.

Divide the Product

By 2103796) 3029466240 (1440 equatareal Minutes sought.
The Number) 4 Cycles.
of the Earth's Rotations
about its Axis. A. M. 5760 in Connection with A. D.
1753, when Dr. Bradley made his Observation at Greenwich.

In Regard to your other Question, *Why I made*

made Time to begin Oct. 25, and the *Cycle of Years* to end Sept. 22?

To explain myself as well as I can, why these *Cycles* began Oct. 25, and ended Sept. 22. I observe, that the *Julian Year* consists of $365\frac{1}{4}$ Days, (or Rotations of the Earth,) but this Quadrant, or Quarter of a Day, or six Hours, is not compleated on the same Meridian where the Rotation began, but 11 Minutes more Eastward on the Equator. — This Precession of 11 Minutes of *Rotation Eastward*, makes 11 Minutes in *Time Westward*, (as in the Calendar); so that the precise Length of the Year is 365D. 5H. 49M. Thus, if the Solar Year began in any Meridian, exactly at Noon, the second Year it would begin 11 Minutes before six in the Evening; the third 22 Minutes before Midnight; the fourth 33 Minutes before six in the Evening, and end 44 Minutes before Noon.— Hence a Day is added to every four Years, and that Year is what we call *Bissextile or Leap Year*: And in a Cycle of 1440 Years, having passed every Minute on the *Equator*,
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the Year and Day will begin again together, in the same Meridian, but not on the same Day of the Week. — Hence the Day of the Week, and not the Day of the Month, must be the *Characteristick* to distinguish the Cycle.

The Julian Year (as observed) being 11 Minutes longer than the solar tropical, the Day of the Month, (according to the Julian Calendar,) from the Year of the Creation, or the Year of the Julian Period 706, had receded 44 Days, which brought the Day of the autumnal Equinox from Oct 25, which it was in the Julian Year 706, to Sept. 11, O. S.; but 11 of these Days being thrown off, in the Year 1752, in Order to bring the Equinox *nearly* on the same Day of the *Julian Month* which it was at the Nicene Council, which was held 1439 Years before; it brought the Day of the Month, (when the Sun entered Libra,) from Oct. 25, at the Creation, to Sept. 22, N. S. 1753.

In Regard to what passed between you and me, about Sir Isaac Newton's Assumption of
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Gravitation and Attraction, I think you misunderstood me: I did not oppose them, as *Effects*; but I would not have it understood that we ought not to be satisfied in going thus far, and no farther; — I contended that we ought to have Liberty to enquire what Agent, or Agents, were the Cause of these Effects; and not to make Use of Words which seemed to point out some occult Quality, and that it was the *ne plus ultra*, and improper to enquire any farther. — No! We ought to use these Words, as *Sir Isaac Newton* has directed, only to express *Phenomena* in Nature, to which he was going to apply his mathematical Demonstrations: Thus in his *Opticks*, (which was one of his last Works,) says he, “ I would have Gravitation and Attraction to be understood as an *Effect* only, “ *which might be occasioned by the Pressure of* “ *a most subtle Ether*, (with which the Space, “ from the Sun to the Extremity of the System might be filled,) or to something which “ he did not know.”

Daily Experience shews us, that Gravitation

tion and Attraction are *relative* Terms only, as Gravity and Levity, and are always in Proportion to the *Specific Gravity* of the Body, and the Density of the Medium that surrounds it. As, for Instance, drop a piece of Cork out of your Hand, in the Air, it will be forced to the Ground, by being of a greater specific Gravity than the Atmosphere; put this Piece of Cork at the Bottom of a Bason, cover it with Water, and the Cork will be forced upwards, and lie in the *Medium* between Air and Water, higher or lower in Proportion to its specific Gravity. The Experiments on Balloons greatly confirm and explain the above Theory.

The following Axioms (I think) are allowed by all Phylosophers: 1st, that Matter cannot act but when acted upon; 2dly, that it occupies Space, and cannot act in two Places at once, but only in the identical Space it occupies; therefore it cannot act at a Distance from itself, or in any Place it does not occupy. Hence it must be the *surrounding Medium* which causes the Gravitation of Bodies.

dies.—Thus, as was observed by the Cork; — a Body, placed in any fluid Medium, will rise or fall, in that Medium, in Proportion to the specific Gravity of that Body, and the Density of the surrounding Medium.

My Assumption is, that the *first Agent* in Nature must be the most *subtile* (or *active*) and *universally expanded*, and capable of entering all Pores, and Interstices, of the most dense Substances in Nature, even *Adamant*!—And I suppose that the *Ether*, which Sir Isaac Newton imagined, ⁽⁹⁾ might, by its Pulsion, be the Cause of Gravitation and Attraction, & be composed of two Qualities; which, for the Purpose of being understood, (not being able to find more proper Names,) I will call Heat and Cold.—I suppose this *Ether* to occupy all Space, from the Sun, at the Centre, to the utmost Extremity of the System; which *two* Qualities are in continual Conflict, in the Manner we have observed ⁽¹⁰⁾ the cold and hot Air, or Atmosphere to be.—These Ethers, mixed with the Atmosphere, being

(9) P. Def. V, VIII—Lib. I, Sec. II.

(10) See Letter IV, Page 164.

being the Cause of the Conflict, we always observe, between hot and cold Air; each endeavouring to possess the Place occupied by the other; — the Heat expanding, and the Cold compressing. If they are the first Agents, their Power will be indefinite, and capable of destroying all material Substances, as we have numberless Instances and Experiments every Day, which confirm it. Does not the Experiments in Electricity prove that it is universally expanded and enters all Substances, and that it is in all Matter, Ice not excepted?

Boerhaave, and a great many Philosophers, have thought that Motion and Fire were synonymous Terms, as has been observed.⁽¹¹⁾ Viz. where Fire abounds, there will be the greatest Motion, and Cold the opposite. — Hence we see the Cause of all Winds, Hurricanes, Earthquakes, &c. which destroy every Thing, and force all before it: *in those, the Phenomena* of Attraction, Gravitation, and Cohesion, are all lost. — Hence may be observed, that all Matter, by having Fire added to it,

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(11) Letter V. 169.

is expanded, and occupies more Space. Thus the Sun Beams, striking against the Earth, a great Part of them are reflected, and of Consequence there must be a greater Quantity of these Sun Beams, or Heat, at the Surface, than at an Inch from it, and a greater there than at two Inches, and so on.—When the Rarefaction is made on the Surface of the Earth, the Cold, or more dense *Ether*, rushes towards the Earth, together with the Atmosphere, and forces this *light*, Heat, or rarefied Air, upwards from the Earth; and with it every thing that is of less specific Gravity than the Atmosphere. — The Earth, being placed and surrounded with these Ethers, it has no more Resistance than a Body, of the same specific Gravity, placed in the middle Part of a Tub of Water;—it would neither rise to the Top, nor gravitate to the Bottom, but would remain in the Middle, and move as the Body of Water moved; unless by Means of Heat, or some other Cause, the watery Medium, on one Side, should be expanded, & made to occupy more Space, and to be of less specific Gravity than it was on the other :

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If this was the Case, then the Medium, or Water, on the other Side of the Body, having greater Gravity or Pressure, would force itself into that Place of lesser Gravity, and of less Resistance; and, by that Pressure, would force the Body to turn round together with it. — Thus the Earth, being placed in and surrounded with Ethers, can have no Resistance: The side of the Earth next or opposite the Sun, having the Atmosphere heated and rarefied, and the other Side covered with cold and dense Ether;—this cold and dense Air, by forcing itself into the Place occupied by the hot and rarefied, carries the terraqueous Globe round with it. Thus, the Heat from the Sun, and the Cold from the Extremities, continually acting, cause the perpetual Motion of the Earth. Hence, whilst these two Motions remain a Ballance to each other, so long would the Earth go round the Sun; going round its Axis also at the same Time.— Does not all Experiments in Electricity, Gunpowder, and the late Experiments on Balloons confirm it?

Hence

Hence, the greatest Heat, or Rarefaction, being on the Earth, every Body of greater specific Gravity than the Atmosphere, is forced towards it; and contrary, all Bodies of less specific Gravity, are forced from it. hence the spheroidical Shape of the terraqueous Globe; for if the Water, or fluid Parts, are pressed by the cold at the Poles, more than they are at the Equator, they must form a Spheroid, as Experiments on the Shape of the Earth have proved it to be.—Hence also, we are informed of the Cause of the Tide, or Sea, always flowing from the Poles to the Equator; (as Cook, in his Voyage to the South Pole, found they always did); and this is also observed at Nova Scotia, Newfoundland, that the Tide always flows from the North Pole towards the Line; which is contrary to the Doctrine of Attraction; for the Earth being a Spheroid, longest at the Equator, the Tide flows uphill, or from the Centre of Attraction. — The fall of Bodies is also proved not to be in an exact Perpendicular to the Place they fall from, but more towards the Equator, or where the Rarefaction
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is the greatest, and Resistance the least.— Another Experiment, which also seems to prove the above is, that when they drop a Weight, or Lead, into the Sea, to try its Depth, the Pressure, or Weight, on the Finger, cannot be felt at more than Two Hundred Fathoms, let the Weight be as great as may be; and the Pressure of the Line, on your Finger, becomes less and less every Fathom it descends.— Was the Attraction the greater, the nearer it comes to the Centre of the Earth, the contrary of this would be the Case.— I should imagine, that was a Barometer to be carried down Two Hundred Fathoms, into some of our deepest Coal Pits, the Quicksilver would sink in Proportion as you descended, in the same Manner it does when you ascend into the Atmosphere: But this is a mere Hypothesis, which I believe has never yet been tried; but I much wonder at it, as we are so curious in Experiments — If you have any inquisitive Acquaintance amongst the Coal Miners, who may be willing to make this Experiment, I think it would be a useful one.

Thus,

Thus, you see, I do not oppose any of Sir Isaac Newton's mathematical Demonstrations, (who, perhaps, was the greatest Mathematician that ever lived,) nor his Calculations of the *Effects* the Sun, Earth, and Moon, &c. have on each other; — I only lay a Claim for Liberty to explain the *Causes* of these *Effects*. — The whole Difference lies in This; whether the first *Agents* in Nature be Solids or Fluids: — Most of Sir Isaac Newton's Followers believe that they are in *Solids*. I, on the contrary, think they are in Fluids; the most subtile, the most active; therefore, as from Experiments, Fire seems to be the most subtile and active; of Consequence the *first material Agent*. — Indeed there was one Thing else, which was contended for a great While; but, I believe, is now given up: Viz. that the Space between the Sun, Moon, and Earth, was *void* of Matter, a *Vacuum*; otherwise, say they, if it contained Matter, it must have Resistance, which, on these Principles, would have overcome all Motion before now.—For, say they, a Body once put in Motion, will always continue

continue in Motion, if it meets with no Resistance, but if it meets with Resistance, it would be continually losing Part of its Motion, every Minute, and in Time stand still; which must have been the Case with the Planets, before now, if they met with any Resistance.

I am,

DEAR SIR,

Your obliged and

Faithful Friend,

F. PENROSE.

STONEHOUSE,

Monday, April 11, 1785.

TO F. PENROSE, ESQ.

Doubts proposed concerning some Parts of Mr. Penrose's Philosophy, in Order that Truth may be ascertained. Queries concerning cold Ether; and the Pressure of that cold Ether into the Hot, or where it is more rare.— What is the Cause of the Motion of the Earth?— What is the Cause that the Earth does not fall into the Sun? — Do you impute it to a Current of Ether? — Answer to the last Queries conclusive, if it be allowed that Moses was so far ignorant of Astronomy, as to be incapable of calculating the Eclipses which preceded his Time. — He is said to have been learned in all the Learning of the Egyptians; — State of the Sciences in Chaldea and Egypt.

DEAR SIR,

I SHOULD have thanked you for your obliging Letter sooner, but that I have been a good Deal out of Town; and I have had

had a lurking Sort of rheumatic Fever hanging upon me for more than a Month past, which broke my Rest and Spirits very much, and thereby made me reluctant either to write, or to set about any Thing else. Thank God, I have almost got rid of it within the last Fortnight, since the Weather has been warm. I am greatly obliged to you for the Trouble you have been so good as to take, to inform me of your philosophical Principles, and shall make no Apology for offering some of my Doubts to your Consideration; because without a fair and candid Discussion, of any Subject, *Truth* cannot be ascertained. In strict Propriety indeed, I ought rather to say, I must beg some farther Illustration, on some Points which I do not understand, nor see the Consequences which you draw from the Premises,

I have lived a Life of such Hurry lately, that the above has been wrote at *twice*, and each Time a Week from the other, tho' I have taken every probable Opportunity of having Half an Hour to myself; and 'tis odds
whether

whether I shall not be interrupted now, in five Minutes.

To begin—Heat and Cold are certainly relative Terms, as up and down are; and some Philosophers deny them totally: But I do not mean to quibble about Terms; for no Doubt there are such Effects produced as we call by those Names.—Nor have I any Objection to your *Ether*; for I think there probably may be such a subtile Matter, which pervades every sensible Substance that we are acquainted with.—But when you talk of the *cold* Ether driving out the *hot*, do not you recur to that *Gravity* which you want to explode? For by saying that the *Density* of the former causes it to rush into the Place of the latter, because it is there more rarefied, &c. is allowing of a Principle, little if at all different from our Ideas of Gravity.—The Instances of a Cork, or Piece of Wood put into Water; the Air Balloons, &c. &c. all go to the same Principle; for they will all of them *rest* when they come into a Medium of equal *Density* with themselves; and *in this Case*,

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Density

Density and Gravity seem to me synonymous Terms.

I will also readily grant you, that the Sun Beams acting strongly upon that Surface of the Earth, which is opposite the Sun, will rarefy the Atmosphere there, and that the dense cold Air on the opposite Side the Earth, will then push it forward into that rarefied and lighter Atmosphere: Nay, I will grant you that it will cause the Motion round the Axis of the Earth, (though I by no Means think that a *rotary* Motion must *necessarily* follow from it,) yet I would ask why the Earth did not proceed in a straight Line directly to the Sun? — We will suppose the Earth this Instant formed, and at rest: The Sun Beams play upon it, and rarefy the Air on that Side which is opposed to them; (I shall take the Liberty of using the Word *Air*, as a shorter Word, instead of *Atmosphere*) the dense Air on the other Side will push it forward into that lighter Air most certainly; but I do not see why it should cause a rotary Motion round the Axis of the Earth; much
less

less can I see any Reason for its elliptick, annual Motion from *this* Cause; Recourse must therefore still be had to an original Impulse, or trajectile Force, for its annual Motion; and then what is the Power that brings it back from that immense Distance at which it is, in the Summer Solstice? or prevent its flying off in a Tangent? If the mere Rarefaction of the Air was sufficient for this, would it not cause the Earth to fall plump into the Sun, and not take that circuitous Course which we see it does? Would you impute it to some Current of the subtile Ether? We know and allow that there is such a Current from North to South, which is the Cause of Magnetism; but that will not serve to carry the Earth round its annual Orbit.— Or would you assign various Currents for that Purpose? If so, there must likewise be a Cause assigned for them, which I fear will be still more incomprehensible than Sir Isaac's Doctrine of Gravitation and Propulsion.— In short, this is the great *Desideratum* in your Theory, which puzzles me, and to which you have not spoke at all in your Letter.—I
readily

readily assent to the Idea that Motion and Fire are the same Thing; *I have always thought it so*: For Fire or Heat has no Existence till Motion is excited.—The Principles of Fire, I presume, lye in Steel and Flint; but it must be drawn out, and put into Action by Collision, and then there is evident Motion. I will not dispute the Cause you assign for the spheroidical Shape of the Earth; though I think that Shape is sufficiently well accounted for by the centrifugal Force, (which cannot be denied to exist) acting upon the Globe while yet moist, during its rotary Motion round its Axis.—I dare say that your Hypothesis, that Quicksilver would fall in Proportion to the Depth it was carried into a Coal-pit, would prove true; and I will endeavour to get a Trial made of it; for I think it would be curious to know whether it falls *in the same Ratio* beneath, as above the Surface of the Earth, and I have a Friend in the North of England, whom I can trust, and hope he will get the Experiment made for me.

I give you many Thanks for the Explanations you favoured me with, respecting the Queries in my last; they are very conclusive, provided that it be allowed that Moses was so far ignorant of Astronomy as to be incapable of calculating the Eclipses which had preceded his Time.—For though he is said to have been learned in all the Learning of the Egyptians, who were at that Time the most learned People in the World: And though the Israelites were originally from Chaldea, (if I mistake not) who were the first People who studied Astronomy; yet I am willing to allow that neither of those Nations were capable of calculating a Series of Eclipses for two thousand Years backwards.—The Consequence is, that Moses must have wrote from Inspiration, and that his Account is a true one.—Yet if I had Leisure, I should like to state some Difficulties which arise from the State which the Arts were certainly in, some hundred Years ago in China; the long Duration of that Empire, (I do not mean their fabulous one) and the numerous Strata of Lava which are found one under another, to great
Depths

Depths under the Earth, and which must have been vomited out many Ages before historical Times; (perhaps before the Invention of Letters) and which would seem to carry us back to Times long before Moses's Account of the Deluge.—But this I must leave to some other Opportunity, having no *present* Prospect of more Leisure than I have now; and I have had so little lately, that 'tis above a Fortnight since I began this Letter, and have hardly been able to write five Lines at a Time; so that I fear you will find it a very confused and unconnected one; which I trust you will excuse, as it arises from a Wish to shew the Sense of your Favour, the first Moment it has been in my Power, rather than defer it longer in order to write a more correct one.

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PRINCE'S-STREET,
May 16, 1785.

TO JOHN HEAVISIDE. ESQ.

Mr. Heaviside's Quere answered.—Calculations of the Motions of the Heavenly Bodies demonstrably true; but the Principles of natural Philosophy cannot be demonstrated with that Clearness and Precision as those in Astronomy.—Three Principles of Matter.—Gravity explained.—Cold and Hot Ether described according to Sir Isaac Newton.—Centre of Gravity supposed formerly to be placed in the Centre of the Earth, but late Experiments prove that Gravity does not tend to the Centre of the Earth, but to the Superficies, and to the Place where there is the greatest expansive Heat.—Gravity proved to be increased or lessened in Proportion as Heat and Cold prevail.—The Pressure of the Cold Ether or Gravity acts exactly in the same Proportion on the Poles and the Equator, as the spheroidical Shape of the terraqueous Globe shews it does.—The Centre of Gravity proved to be near the Surface of the Earth, where every Thing tends.

DEAR

DEAR SIR,

BY your last Letter, we were sorry to be informed that your Constitution had been so much disordered both in Health and Spirits; but as you found Benefit from the Change of the Weather from Cold to Warm, we hope that the late fine Weather has made a perfect Cure.—I am afraid my long and tedious Letters disturb you, and put you to great Inconveniencies, both by reading and writing Answers to them.—Notwithstanding I imagine this to be the Case, I will trouble you with *One* more; as, what I am going to observe may, perhaps, appear satisfactory to *some*, that the World was created at the Time Moses informs us it was.—There may be others who imagine, or *pretend to imagine*, that the World is *eternal*; such Persons, I apprehend, neither mathematical Demonstration, nor any Thing else will convince.

In your former Letter 'you say, that notwithstanding the Sun and Moon were in the Places Moses records them to have been at
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the Time he mentions the Creation to have happened; yet, say you, “may there not have been many Cycles before that Time?” And you observe, that the Chinese History makes that Empire to have been in Being some hundreds of Years before.—In Answer to this I shall again remark, that History, without Chronology, is little better than a Romance; and there can be no Certainty that Chronology is true, unless proved by Astronomy; but when the Sun and Moon give their Testimony to it, there cannot remain a Doubt, they are two faithful Witnesses.

Now, Sir, as to this Question, I observe, that I never undertook to prove, by Mathematical Demonstration, that there might not have been a Series of Years before the Time in which Moses places the Creation.

To prove a Negative is always attended with great Difficulty, and often impossible! What I attempted was to try Moses's History and Chronology, by the Evidence of Astronomy,

nomny, and to examine whether the Sun and Moon were in the same Places in the Heavens, as Moses tells us they were, at the Time when the Creation happened; which your astronomical Friends allow I have done.—This appears to me to be Evidence sufficient to establish any other History: If so, why should it not Moses's History?—And it is not credible that he would have calculated those Places of the Sun and Moon, two thousand Years before he was born.—If he could not, and we find it in his History, it must be revealed from God, as he tells us it was!

As I observed to you before, I assume, (from Moses's History, and Dr. Bradley's Observations) that the Moon was Full, and in her Node, A. I. P. 706, Oct. 24th Day, 10th Hour, 24th Minute, at Night, in the Meridian of Greenwich Observatory; between that Time, and the Year 6490, which is in Connection with A. D. 1783, when, on a Wednesday Night, the third Year after Bissextile, there happened an Eclipse of the
Moon,

Moon, Sept. 10th Day, 12th Hour, 40th Minute.—Between these two Points of Time the Earth made 5789 Revolutions through the Ecliptick, and was intersected in her 5790 Revolution, by the Moon, 12th Day, 16th Hour, 14th Minute, before she entered Libra; during this Time she made 2114741 Rotations round her Axis.—While the Earth was performing these Rotations, the Moon performed 71,612 synodical Revolutions, and intersected the Earth as above.—Here we have two Points of Solar Time, Oct. 25th, 706, Julian Period, the Sun in Libra, and Sept. 22d Day, 16th Hour, 54th Minute, 6490, I. P. the Sun in Libra, measured by the Number of Rotations the Earth made between them.—We have also Oct. 24th Day, 10th Hour, 24th Minute—706, when the Moon was in Opposition to the Sun; and Sept. 10th Day, 16th Hour, 40th Minute, 6490, when the Moon was observed to be in her Node, and exactly opposite to the Sun, (by the Eclipse which then happened.)—Between these two Points, the Time is measured by the Number of Rotations the Earth

has

has made, *with as much Ease, and as great an Exactness*, as the Distance between any two Places are by a Surveyor's Wheel.

Hence also by knowing the Quantity of the Motion of 71,612 Lunations, we shall have the precise Length of Time of one Luration.—Here you have *mathematical Precision!* As the Interval which lyes evenly between those two Points, is measured by the Number of Rotations the Earth has performed during that Time; and also the Point of Interfection where the Moon ends her 71612th synodical Revolution, measured with the same Exactness, and also the Distance between that Point of Interfection, and that other, when the Sun entered Libra.—Hence I remark, that the Revolutions of the Moon, when compared to those of the Earth, are so complicated, so curious, various, and exact, that it requires 7,948,800 synodical Revolutions, which are more than 600,000 Years for Her to go through all her Variations, and to cause the Moment of her mean Opposition to fall again on the same Point of the Equator,

tor, in the same Meridian, on the same Day of the Week, and the same Year of Biffextile. ^(a) —This appears to me to be sufficient Evidence, that the World was created at the Time when Moses informs us it was, and that the History of the Duration of the Empire of China is fabulous.

I have teased you thus far on a Subject that must appear *dry* to any one who does not take a particular Pleasure therein; with a Desire, (if it is not too troublesome,) that you would shew it to those Gentlemen who joined with you in Quering whether there might not have been *Solar* Cycles before the Time when Moses places the Creation to have happened.

In Order to give you some Satisfaction for this Trouble, I will promise that I will ask no more such Favours; for I am satisfied, the Trouble of perusing and making Remarks thereon, must be very vexatious to one who has so little Time to spare.—If you should

(a) Kennedy's Chron. P. 196.

should have an Opportunity of shewing the above to the Gentlemen who saw the other, be pleased to inform them, that the above Calculations were made without *Tables, Equations, or Anamolies*, after a most easy and simple Manner; by the first four Rules of Arithmetic only. ^(b)

I observed to you in one of my Letters some Time ago, that as the first Principles of natural Philosophy could not be demonstrated with that Clearness and Precision as those of Astronomy, I deferred entering upon them.—In Astronomy we only calculate and demonstrate the Phenomena of the Motions, which the Heavenly Bodies are known, and *observed*, to have.—Sir Isaac Newton, in his Philosophical Calculations, went no farther than this, and therefore they are *certainly true*: But if we Philosophize, or draw Inferences from them, we must always take Care that they flow easily from, and are not in the least contradictory to the known Principles of Matter.—Now, Sir, the following
are

(b) Introduction, P. 80.

are Principles of Matter, which I believe are allowed by all Philosophers,—1st, that Matter occupies Space, and has Resistance.—2d, that no two Particles of Matter can occupy the same identical Space, at one and the same Time.—3d, that it can only act where it is present, *not the least Distance from the Place it occupies.*

Now, I believe, you and I, and all Philosophers, have seen and observed the EFFECTS which the Heavenly Bodies have on each other, known by the Name of *Gravity*. I endeavour to account for these Effects by the Ethers, *or the Matter* which fills the Heavenly Space, in the same Manner as Sir Isaac Newton supposed, and consequently is in *Contact* with them. ^(c) This is my Theory and my Ideas of it.—Without this *Ether* occupying the Space between them, I shall be glad to be informed how they act on each other, in a *Mechanical Way*, and not by saying *that Gravity is the Cause of it*; which is no more than saying that a Ship sailed from
London

^(c) See Let. IV. P. 162.

London to Plymouth, without telling us that the Air was a continued Medium between the two Places, and that a Current of that Air or Wind carried her there.—Do you suppose that Gravity is (as it is often explained) *something superadded* to Matter? If so, is it spiritual or material? If material, it must act according to the known Laws of Matter.—If you say it is spiritual, there must be an End of the Controversy, for it is what I don't understand, and must not pretend to explain.—I should also be glad to be informed, that if the Motions of the Earth or Planets are occasioned from an *original Impulse or trajectile Force*, *how this Force is continued and supported?* For if you allow Matter to reach from the Planets to the Sun, and to the End of this System, it must *resist*, and if it resists, it must have taken off such a Quantity of the trajectile Force, that they must have stood still Ages ago; when, in Fact, we know their Motions are the same they were some thousand Years ago.—These are Difficulties which I think will not be surmounted, till we allow the *first Agency in Matter to be*
in

in Fluids, and not in Solids, and the more Subtile the Fluid, the greater the Agency.

In my last Letter, when I mentioned the different Modifications of Ether, I told you that I used *Heat* and *Cold*, (if possible,) to explain my Ideas of them, though I did not think them proper ones, but I could find no better; but then I did not join the Ideas of the Sensations which Heat and Cold have on our Bodies, but pure elementary Heat and Cold, such as may be observed from the Effects of Lightning, and electrical Experiments.

These Ethers I endeavoured to explain by a Quotation from Sir Isaac Newton, who calls them *Spirit* and *Light*; I there desired to be understood in the same Manner whenever I made Use of them. ^(d)

In this Year's Philosophical Transactions, there is the History of Experiments made on the Difference of Cold on the Earth, and, at

N n the

(d) Letter IV. P. 163.

the same Time, at different Heights from it; which are curious and worthy to be read: The Gentleman that made them, (whose Name, if I remember right, is Cavendish,) observes, that Cold is reflected, rises or flies off from the Earth, as well as Heat.—According to my Theory, both *Heat* and *Cold* must be intercepted by the Earth, and be reflected from it, by interrupting their Passage, whereby they are made to rebound from it.

As you seemed to be puzzled by the Use I made of *Heat* and *Cold*, and that you understood thereby, that I wanted to explode *Gravity*; I shall therefore endeavour to explain my Ideas of that *Phenomenon* of Nature, which is certainly a just and true one, and not to be disputed; therefore, I hope, you will not imagine I wanted to explode it.—My Design is to clear it from some Difficulties attributed to it, and to elucidate its Power.—In Order to do this, I shall take the immortal *Newton* for my Guide, who tells
us,

us, ^(c) “ That the *Ether* which fills the
 “ heavenly Spaces, is a *Medium* which per-
 “ vades all Bodies, and that there is *no Va-*
 “ *cuum* but what it fills; that it readily per-
 “ vades all *Bodies*, and by its elastic Force,
 “ is expanded through the whole Heavens,
 “ and that it may suffice *to impel* Bodies from
 “ the denser Parts of the Medium to the
 “ Rarer, with all that Force or *Impulse* which
 “ we call GRAVITY.” ^(f) He also describes
 this Medium to act with a *two-fold Quality*,
 which he calls *Light* and *Spirit*.—The one
 expanding itself from the Sun, and the other
 condensing and pressing this expanded *Ether*
 towards the Sun. — That these opposite
 Forces are carried on in a *vibrating* Manner,
 being alternately in Fits of easy Reflection,
 and easy Transmision.—In Order to shew
 the Place where the Centre of Gravity is
 supposed to be, and how it acts, I shall give
 you the Description of it by Mr. Ferguson.
 “ Bodies, says he, are heavier near the Poles,
 “ than those towards the Equator, *because*
 “ *they are nearer the Earth's Centre, where*
 “ *the*

(c) Optick, P. 323, 325.—(f) Letter IV. P. 136.

“ *the whole Force of the Earth's Attraction*
 “ *is accumulated.*—Bodies carried from the
 “ Poles towards the Equator, gradually lose
 “ their Weight.—Experiments prove that a
 “ Pendulum, which vibrates Seconds near
 “ the Poles, vibrates slower near the Equator,
 “ which shews us that it is lighter or
 “ less attracted there.—To make it oscillate
 “ in the same Time, it is found necessary to
 “ diminish its Length.—By comparing the
 “ different Lengths of Pendulums swinging
 “ Seconds at the Equator, and at *London*,
 “ it is found that a Pendulum must be $\frac{160}{2 \times 1000}$
 “ Lines shorter at the Equator than at the
 “ Poles.” (g) It is also observed that the *cold*
Ether at the Poles, gives a *gravitating* Power
 to Bodies removed there from the Equator,
 nearly as $\frac{1}{222}$ — Does not this Fact shew us
 that the *cold Ether*, or, as Sir *Isaac Newton*
 calls it, *Spirit*, makes Bodies to gravitate,
 and is the Cause of Gravity as he supposed it
 did? Thus we find that the *cold Ether* presses
 at each Pole, just in the same Proportion,
 more

(g) Ferguson, P. 50, S. 117.

more than the *hot Ether* at the Equator. As the equatorial Diameter of the Earth exceeds the polar Diameter in Measure.—By the Experiments of *Messrs. Maupertuis, &c.* in the Years 1736 and 1737, the equatorial Diameter of the Earth was found to be $36\frac{948}{1000}$ Miles more than the Polar, which is $\frac{1}{224}$ nearly.

Hence it may be observed, that the spheroidal Shape of the Earth is exactly according to *Gravity* or the *ethereal Pressure*.—For the cold Ether is found to press or make *all Bodies* to increase in Gravity there, just by the same Proportion as the Equatorial Diameter of the Earth is longer than the Polar.

Now, Sir, if the cold Ether gravitates in that Proportion, more at the Poles than it does at the Equator, the terraqueous Globe must be in the Shape it is found to be.—For it is the Property of Fluids to *move easily* in every Direction, and to *acquire* a uniform Surface in Proportion to the Pressure on it.

Thus

Thus the Air is a fine elastick Fluid, surrounding this terraqueous Globe, and is found by Experience, to be compressed or condensed by *Cold*, and expanded or rarefied by *Heat*. The Seas are a watery Fluid, giving Way to Pressure, and surround this Globe; therefore if they are pressed more at each Pole, occasioned by the *Cold*, than at the Equator, where they are expanded by *Heat*, they must be in the spheroidal Shape as $\frac{1}{222}$ nearly.

Having shewn that the *cold Ether*, pressing more at the Poles than at the Equator, is the Cause of the spheroidal Form of the Earth, I shall endeavour to find, from Experiments and the *Phenomena* of Nature, where the Centre of Gravity is, or the Place where it tends.

It was observed in my last Letter, that Dr. *Halley*, many Years ago, found that a Weight dropped from above, does not descend according to the Perpendicular of that Place, but a little to the Eastward of the South, tending to the Place on the Globe where the Rarefaction

faction is the greatest, and the Heat the strongest.—The Tides at Newfoundland are found to tend in the same Manner a little towards the Eastward of the South.—In like Manner later Experiments have proved, that a Plumb Line placed on each Side of a Mountain, will not descend Perpendicular to the Centre of the Earth, but, *on both Sides*, tends towards the Mountain; the Place where the greatest Number of the Sun Beams are reflected, and where the Heat is the greatest.

It has long been an Observation amongst Sailors, that Gravity was lost about Two Hundred Fathoms under the Surface of the Sea: That when they sounded with a Line longer than that, they could feel no Effect from the Weight, let it be ever so great; and by a late Experiment it has been found, that if you suspend a Pound Weight at one End of the Scale Beam, and at the other End hang another Pound Weight, by a fine String, over a Shaft or Mine, and let it descend gently below the Surface of the Earth; it loses Part of its Gravity as it descends,
till

till it comes to Nothing; and the Weight must be lessened in that Scale above Ground continually, to make an *Equipoize*.—From the same Cause it is found by Experience, that Candles will not burn but about Two Hundred Fathoms under the Earth's Surface.

The above Experiments shew us, that the Force of Gravity does not tend to the Centre of the Earth, as has been imagined, but to the Place where the *expansive Force and Rarefaction from Heat, are the greatest*.—Thus, where the Sun Beams are most reflected, and their expansive Force the greatest, there the Pressure of the *cold Ether* or Gravity will tend.—They also shew us the Reason of the spheroidal Form of this terraqueous Globe, and why the Waters or Tides are always flowing from each Pole, towards the Equator.—Hence it may be observed, that *Heat* and *Cold* are the Causes of *Gravity* and *Levity*; Heat enters, projects, and expands the Parts of Bodies, and makes them specifically lighter. On the contrary, *Cold* presses them closer together, and increases their *Attraction of Cohesion*,

hesion, and adds to them *Gravity*. — Do not the above Experiments shew us the Cause of *Gravity*, and how it acts?—Thus, Sir, you may observe it is not my Design to deprive Gravity of any of its Powers, I only mean to endeavour to point out the Cause of that *Phenomenon*.

From what has been observed, it appears, that as *Heat* is the Cause of Projection and Expansion, so *Cold* is the Cause of Compression and Gravity: That these two Ethers are in a continual Conflict or Vibration; each endeavouring to jostle the other out of its Place.

You also imagine that *Density* and *Gravity* were synonymous Terms. The Ideas I used them for is quite opposite: I suppose Gravity an *Agency*, forcing every Thing towards the Body or Place to which it gravitates: On the contrary, I suppose the *Density of the Medium between* two Bodies, the Resisting Quality.—I never did or ever will make Objections to Author's Terms, so he does but

O o

explain

explain what he means by them.—The Earth cannot fly off in a Tangent, no more than a Balloon can fly into the Sun. The Earth is placed in a *Medium*, (surrounding the Sun,) of *the same Specifick Gravity* with it, therefore it cannot depart from, or approach nearer to the Sun, than that Medium reaches, in the same Manner as a Balloon or a Cloud; it must continue at the same Distance from the Earth, unless its specific Gravity is altered, by throwing out Ballast, or letting out some of the light inflammable Air. — By these Actions the Balloon will either rise or fall, as its specific Gravity is lessened (in Proportion to the Atmosphere) by throwing out Ballast; or its gravitating Quality is increased, by letting out inflammable Air. — Hence, as you justly observe, *Heat and Cold* are relative Terms, as all Parts of Matter are to each other.

I return you many Thanks for the Trouble you have taken, in Order to get the Experiments on the Barometer tried, in some of our deep Coal Pits; I wish you had joined the

Let. XIV. *On natural* PHILOSOPHY. 291

the Thermometer with it.—I am much surprised they have never yet been tried, as we live in an experimental Age.

I am,

DEAR SIR,

With great Respect,

Your obliged humble Servant,

F. PENROSE.

STONEHOUSE,

June 18, 1785.

To

TO F. PENROSE, Esq.

State of the Sciences about two thousand Years ago.—The former Query repeated: “ If the Earth, &c. were first put in Motion by the Heat of the Sun, rarefying the Atmosphere between these Bodies, why did not the Earth immediately gravitate into the Sun?—Must not a trajectile Force have been at first necessary to cause its annual Orbit ?”

DEAR SIR,

TIS now above ten Weeks since I was favoured with your last; a shameful Time I confess! And yet I wish that I had not so good Reasons to give for my seeming Negligence.—The Illness of a particular Friend confined me here in Town, during all the hot Weather, till near the Middle of August; by which I was reduced to such Weakness and Langour, that I could neither write, or do any Thing else; and if my Confinement here had continued much longer, I could not have supported it; for never having
got

got rid of the Illness I had last Autumn, the close warm Air of this Town, for so long a Time, quite overset me; so that when I was at Liberty to get out of Town for a few Days, I was not able to ride on Horse-back more than six or eight Miles at a Time; nor have yet been able to ride from hence to Potterels, without taking a Post-Chaise at Barnet. About three Weeks ago I set out, (but in a single Horse Chaise,) on a little Ramble thro' Norfolk and Suffolk, which has done me a great deal of good, and enabled me to venture on a little Sea-Bathing, so that I shall set out for Margate to-morrow Morning, where I hope to recover some Part, at least, of the Strength I have lost.—However, my own Illness has not been the sole Cause of my having so long deferred to thank you for your last obliging Letter.

Since I was favoured with your last, I have had no Opportunity to see any of my Mathematical Friends, they having left Town long ago; I must therefore wait for their Opinion till Winter brings them back again; consequently

quently I can only give you a few of my own trivial Remarks upon it.

First then, I entirely assent to what you say, as to the Time of our Saviour's Birth. 2dly, I think there is *very great Probability* that you have also fixed the Creation of the World rightly, and proved that the Mosaic History is true.—I say, *very great Probability*, because it is still *possible*, that the World *may* have existed 600,000 Years, which you say it would require to compleat all those various Revolutions among the Heavenly Bodies, which are necessary to bring them again into the identical Situation they must have been in at the Time of the Creation.—What strongly induces me to believe the World cannot have existed so long, is, the very low State that all the Arts and Sciences, (particularly the former) are well known to have been in 2000 Years ago: Astronomy being almost the only Science that seems to have been cultivated prior to that Period.—Indeed, about that Time the Mathematicks and Mechanicks seem to have made a prodigious Progress

gress under Archimedes ; but I think it appears that they were not generally understood, for tis plain the Romans were totally ignorant of them.

Another Proof, I think, is the total Want of Civilization among Mankind, at that Period ; a very few Nations (if any) perhaps excepted.—So that you see I am far from objecting to your Opinions, though I am forced to draw my Reasons for approving them, from other Fountains than you do, and by no Means so good ones.—I am not so *perfectly* well satisfied with your Natural Philosophy, though I acknowledge that you Support your Ideas well ; but being now upon the Wing, I have not Time to state and explain my Objections so thoroughly as I wish to do.

In the first Place give me Leave to observe, that you have given me no Answer to the Query I put in my last, viz. That if the Earth, &c. were first put in Motion by the Heat of the Sun rarefying the Atmosphere
between.

between these Bodies, why did the Earth not immediately gravitate and fall into the Sun, as the Medium between them must have been much more rarefied then it could be any where else, or in the Course they took? And if so, must not a trajectile Force have been at first necessary to cause its annual Orbit? For I will allow that the Sun's Heat might cause the diurnal Motion, as you explain it in your former Letter, provided *that* Heat did not cause the Earth to fall directly into the Sun, as I said above.

You did not rightly apprehend my Meaning, I see, when I said that Gravity and Density were synonymous Terms; I only meant that Bodies gravitated through any Medium, in Proportion to the Density or Closeness of the Matter of which they are composed; as that a Pound of Lead will gravitate sooner than a Pound of Feathers, and so forth; but did not apply it to the Medium through which they were to fall, for *that* will certainly obstruct the fall of both, in Proportion to its Density, and the *Bulk* of the falling Bodies.

After

After all, I fancy that I do not fully comprehend your Ideas of Heat and Cold, as to the Degrees and Situations of them.—I know that you suppose that the greatest Degree of the former is on the Surface of the Earth; in which you, no Doubt, are perfectly right: And it just now occurs to me that you dropped a Hint one Day at Hatfield, (which you did not pursue, or farther explain;) that you did not know but all the superior Regions of the Air were perfect Ice.—If I am right in this, perhaps some Conclusions may be drawn from this Coldness in the Upper Regions, in Answer to my Query; but I have not now Time to consider them properly, as the Time of sending to the Post is now at Hand, for Letters must, by the last Regulations, be sent to the receiving Houses by *Five* o’Clock, which is very inconvenient.—However, I cannot at present see how this Coldness above can prevent the Descent of the Earth to the Sun; because the Air being rarefied near its Surface, would move that Way; and as it advanced further and further, would carry the same Degree of Heat before it, till

P p

it

it arrived at the Source of Heat, the Sun.—
 I write this, (especially the latter Part,) in
 great Hurry, and therefore hope you will al-
 low for the Imperfections of all Kinds; but
 I would not go again from Town without
 telling you how much I think myself obliged
 to you for the Trouble you take in answering
 my idle Queries; and assuring you, that your
 Letters give me infinite Pleasure; I, there-
 fore hope you will never entertain an Idea
 that they can be too long.

I am,

DEAR SIR,

Your much obliged,

And very humble Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

Sept. 12, 1785.

TO JOHN HEAVISIDE. Esq.

Heat and Cold Ether first Agents, according to Sir Isaac Newton, Boerhaave, &c.—Internal Make of this terraqueous Globe described.—The Thickness of the Shell of Earth.—The confused Appearances on this terraqueous Globe, prove that it has undergone some tremendous Convulsions from within, and that the earthly Shell has been burst into Millions of Pieces.—Earthquakes examined, and their Effects described.—These Effects occasioned by Fire.—The Causes of Earthquakes explained,—which prove that there is an immense Quantity of Fire within the Earth.—The above Account agreeable with what is given in the Scriptures.

DEAR SIR,

I WAS sorry to be informed by your last Letter; that you had been so ill, but was glad to find you had nearly got the better of it; I hope the Sea Bathing will perfectly restore you to your former State of Health.

As

As you observe, I did not perfectly explain myself, with Regard to all the Motions of the Earth. —It will require a long Letter or two to do it; but as you desire it, you must thank yourself for the Trouble they will give you.—You want in particular to be informed, “why, according to my Explanation, the Earth does not proceed in a straight Line to the Sun, &c.”—And you say that *Heat* and *Cold* are relative Terms.—They certainly are, with Regard to that Effect on our Senses; but when we mean by them Sir Isaac Newton’s Ethereal Medium, *Light and Spirit*. ^(h) We mean first Agents, which, according to his Definition of them, “fill all the Space between the Sun and Saturn, and beyond; that it is rarer at the Sun, than in the celestial Spaces, and rarer there than at Saturn, and beyond; and may *impel* Bodies from the denser Parts of the Medium, towards the rarer, with that Force we call *Gravity*.”—This compressing Agent he calls “*Spirit* or *Weight*; which, says he, may condense those Vapours
“pours

(h) See Letter IV. P. 163.

“ pours and Exhalations ascending from the
 “ Sun, and make them fall back into him
 “ again, and by that Action increase his
 “ Heat, after the same Manner as it increases
 “ a culinary Fire.”—Hence it may be observed, that Sir Isaac Newton supposes a Circulation from the Sun, to the Extremities of the System, by *two* vibrating Agents.—*The Ethers* ;—the one, going out, issuing from the Sun, in Form of *Light*, and the other returning in Form of *Spirit*.—And, as was before observed, *Boerhaave* has proved by the heating and cooling of an Iron Bar, &c. that Heat is the first *Agent* or *Mover*, and *Cold* the Compressor, Contractor, or *Gravitator*.—But before I explain myself any farther, it will be necessary to get the best Information we can, concerning the internal Make and Contents of this terraqueous Globe: This appears to be a difficult Task! and if you remember, when we first entered on these Disquisitions, I entered the following *Caveat*, “ viz. ⁽ⁱ⁾ “ That there may be some *Arcana* in the Mechanism of Nature, that may be beyond

(i) Letter IX. P. 274.

yond our Power to explain ;” for it cannot be thought that we can give a mechanical Solution of all its Operations.—However, I shall not *now* take any Advantage from it, but endeavour to answer your Questions in the clearest Manner I can.

It is related in the History of the Deluge, that the Waters were fifteen Cubits above the highest Hills ; and that there was an Expansion in the *Midst* of the terraqueous Globe ; and that the Flood was occasioned by the Waters proceeding through the Fountains and Openings from the great Deep.—After the Waters had prevailed the Time God appointed them, he caused a *Wind* or *Spirit* to force them back again from whence they proceeded, whereby the Earth became Dry. And Job tells us, ^(k) that God had made the Spirit the Instrument of Gravity.

Now in Order to conjecture the Thickness of the earthy Shell, we will allow, three Miles above the Earth (which, is generally reckoned)

(k) Job XXVIII. 25.

reckoned) to be the Measure of the highest Mountains; four Miles for the Thickness of the earthy Shell, and other three Miles for the Waters within the Shell; all this will be but ten Miles.—But what will ten Miles be to nearly 4000, the supposed Number of Miles from the Surface to the Centre.—This is but as one to 400, which will be as thin a Shell or Covering, in Proportion, as what is made use of to cover a Balloon.

It seems reasonable to conjecture, (as an ingenious Author has observed,) from the natural Appearances of this terraqueous Globe, that it has been burst to Pieces by an expansive Steam from within; for we observe on it Mountains, broken Clifts, craggy Rocks, angular and impending Shores, subterraneous Caverns; together with a vast Variety of Fiffures, Cracks, &c.—All these are particularly to be observed in the Marble or Lime Stone about Plymouth!—And, says this Author, that “without farther Inquiry, “these romantic Appearances are not the “Effect of a regular, uniform Law, but of
“ some

“ some tremendous Convulsions, which have
 “ burst its *Strata*, and thrown their Frag-
 “ ments into all this Confusion and Disorder :
 “ Nay, says he, the very Representation of
 “ Sea and Land, upon a Geographical Chart,
 “ seems alone sufficient to establish the Truth
 “ of such a Conjecture.—The Mountains in
 “ Derbyshire, and the Moorlands in Staf-
 “ fordshire, appear to be so many Heaps of
 “ Ruins :— The *Strata* lye in the utmost
 “ Confusion and Disorder ; broken, dislo-
 “ cated, and thrown into all Directions ;
 “ and their interior Parts are no less rude
 “ and romantic, *full of subterraneous Caverns*,
 “ with every possible Mark of universal Vio-
 “ lence.—Also Blocks of Stone scattered over
 “ the Surface of mountaneous Countries,
 “ and blended with Soils to very considerable
 “ Depths, as if they had been originally
 “ ejected from their native Beds, by *subter-*
 “ *raneous Blasts*, as Stones from Vesuvius
 “ and Ætna. ⁽¹⁾

“ The Fragments near the native Beds are
 “ too

(1) Whithurst, P. 21.

“ too numerous and massy for the Hand of
“ Man to have placed them there, and are in
“ as much Disorder as Stones casually thrown
“ together.—The Banks on the East Side of
“ the River Derwent, from Crick Clift, for
“ twenty Miles up the River, are thus co-
“ vered; and the same may be said of many
“ other Mountains in Derbyshire and Staf-
“ fordshire.

“ These Stones lying so near their original
“ *Stratum*, we may easily satisfy ourselves
“ that they are detached Parts thereof; and
“ by Analogy, the more distant Fragments
“ may be ascertained with equal Certainty,
“ though at the Distance of ten or twelve
“ Miles.

“ In the Neighbourhood of Uttoxeter, in
“ Staffordshire, Blocks of Lime Stone are
“ frequently dug up, of four or five Hundred
“ Weight each; and yet there are no Quar-
“ ries of the same Kind nearer than four or
“ five Miles.

Qq

“ Fragments

“ Fragments of Stone, perfectly analogous
 “ to the former, were dug up at *Etwall*, in
 “ Derbyshire.—A Well being sunk to the
 “ Depth of eleven Yards, many of these
 “ Stones were found, intermixed *with other*
 “ *adventitious Bodies*, from the Surface of
 “ the Earth, to that Depth; some of them
 “ were six or eight Pounds Weight, and
 “ some smaller.—Now although *Etwall* can-
 “ not be less than fifteen or twenty Miles
 “ from any known Quarry of the same Kind;
 “ we cannot help concluding, that they were
 “ originally ejected to that Distance; since
 “ such Effects are frequently produced on
 “ subterraneous Explosions.” ^(m)

The above accurate Description of the na-
 tural *Phenomena* of this terraqueous Globe,
 (as the Author observes,) appears to be Evi-
 dence, that the Shell of the Earth was burst
 and broken into Millions of Pieces, by an
 expansive Explosion from within; and these
 Pieces could not possibly fall together again
 into their primitive Order and Regularity,
 but must leave an infinite Number of Ca-
 verns,

(m) Whitehurst, P. 53.

verns, many Miles, probably many Hundreds of Miles in Length, below the Surface; and I think we may justly conclude, that this happened at the Reformation after Noah's Flood.—Now in Order to shew that there still remains a violent expansive Force, occasioned from the internal Fire, I shall give an Account of the most remarkable Phenomena of late Earthquakes, from the above Author.

At the Earthquake at Lisbon, which happened Nov. 1, 1755, “ The Mountains of Arrabida, Estretta, Julio, Marvan, and Cintra, being some of the largest in Portugal, were impetuously shaken to their very Foundations, and some of them opened their Summits, split and rent in a wonderful Manner, and huge Masses of them were thrown down into the adjacent Valleys. ^(m) This Earthquake was more dreadful in Barbary than at Portugal; at Mequinez, that Part of the City where the Jews resided, was entirely swallowed up.—
“ The

(n) Hist. and Phil. Earth. P. 317.

“ The Mountains were so strangely torn,
 “ that they seemed to be different Shapes
 “ now from what they were.—A large Moun-
 “ tain near Portmorant, near a Day’s Jour-
 “ ney over, is said to be quite swallowed up;
 “ and in the Place where it stood, there is
 “ now a great Lake, of four or five Leagues
 “ over. ⁽ⁿ⁾ In this memorable Earthquake at
 “ Lisbon, not only the Sea, but Lakes and
 “ Ponds were violently agitated all over
 “ Europe.—Now, as Mr. *Whitehurst* observes,
 “ as one of the Properties of the Steam is
 “ Condensation by a small Degree of *Cold*,
 “ the same Degree of expansive Force, can
 “ only exist during the same Degree of Heat,
 “ therefore the incumbent Weight cannot
 “ become elevated to any greater Distance
 “ than the subterranean Fire is continued.—
 “ But on Nov. 1, 1755, the Waters were
 “ agitated through an extensive Country, not
 “ less than 3000 Miles; so that the Steam
 “ must be in one continued Body thus far.”^(p)

Mr. Hook, in his Posthumous Works, P.

302,

(o) *Philos. Transact. Low, Abrid. Vol. II. P. 417.* (p) *Whitehurst, P. 94.*

302, informs us, “ That from Sept. 24, to
 “ Oct. 9, 1650, the Island of Santitirum
 “ was dreadfully shaken with Earthquakes,
 “ but the People were more amazed to see a
 “ horrid Eruption of Fire break out at the
 “ Bottom of the Sea;—previous to the Ap-
 “ pearance of Fire, the Water was consider-
 “ ably elevated in that Place, and the Wave
 “ spread itself round every Way; overturn-
 “ ing every Thing it met, destroying Ships
 “ and Gallies, in the Harbour of Candia,
 “ which was eight Miles distant. ⁽ⁿ⁾

“ The Earthquake filled the Air with
 “ Ashes, and horrible sulphurous Vapours,
 “ and dreadful Lightnings and Thunder suc-
 “ ceeded.—All Things in the Island were
 “ covered with a yellow, sulphurous Crust;
 “ Multitudes of Pumice and other Stones,
 “ were thrown up, and carried as far as Con-
 “ stantinople, and to Places at a great Distance.

“ Nov. 20, 1720, a subterraneous Fire
 “ burst out of the Sea, near Tarcara, one of
 “ the

(n) Whitehurst, P. 64.

“ the Azores, which threw up such a vast
 “ Quantity of Stones in the Space of thirty
 “ Days, as formed an Island about two
 “ Leagues Diameter, and nearly round.

“ In the Year 1767, a solid Stone, measur-
 “ ing *twelve Feet* in Height, and *forty-five*
 “ in *Circumference*, was thrown a Quarter of
 “ a Mile from Vesuvius.”

Now, Sir, in Order to confirm my Theory,
 I have extracted some Observations from Mr.
Whitehurst's State and Formation of the Earth,
 (the Book which you were so kind as to send
 me lately, as a Present,) he appears to me to
 be a diligent Inquirer into the component
 Parts of this terraqueous Globe, and a faith-
 ful Relater of the Observations he made him-
 self, or received from others.—I shall there-
 fore take his Advice, and follow his Exam-
 ple, viz. “ *Not to find Faults with other*
Systems; but to avail myself of such Parts of
them as are applicable to my own Design,” but
 must beg Leave to differ from him *in Design*;
 for he tells us, “ That his *Inquiry* was after
 “ the

“ the *Laws* by which the *Creator chose* to
 “ form the World, and that the *only* natural
 “ *Datum* required, was the oblate, spheroidal
 “ Form of the Earth.”—My Design is to en-
 quire after, and point out, the physical
Causes, how one Part of Matter, acts by
mechanical Laws, on another.

From the above Observations we may na-
 turally conclude, that all the apparent Con-
 fusion and Disorder of the *Strata*, are un-
 doubtedly Convulsions and Effects occasioned
 by FIRE, and fiery Vapours continued with-
 in this terraqueous Globe.—But when we
 compare these tremendous Operations of
 Earthquakes, with those which the Earth
 underwent at the Deluge, when the Alps,
 the Andes, &c. were formed, it will hardly
 bear a Comparifon.

Hence, as Mr. *Whitehurst* observes, ^(o) “ their
 “ Effects leave no Room to doubt the *Exist-*
 “ *ence*, *Force*, and *Immensify* of *subterraneous*
 “ *Fires*; not only under the Bottom of the
 “ Ocean,

(r) P. 84.

“ Ocean, but likewise *under Mountains, Continents, &c. in all Parts of the World.*”

Thus, if the expansive Power, (within this terraqueous Globe, which is occasioned by Fire acting in the same Manner as has been observed,) is continually increasing, it will gradually become equal to the incumbent Weight or Bond which surrounds it; these same Causes still continuing, they will become superior to the Pressure of Gravity from without:—It will then, by Degrees, expand and distend the incumbent *Strata*, and cause an Earthquake, and find a Vent to mix itself with the surrounding Airs without. After this, the Fire and Steam from within the Globe, having expanded themselves, and being mixed with the Atmosphere, (which they will soon do;) the Gravity and Pressure from without, will again take Place, and *compress* and force the Parts of the terraqueous Globe towards the Centre, with the *same Power* it did before this *Phenomenon* happened. But since the astonishing Catastrophe at the Deluge, which made such Alterations in the
terrestrial

terrestrial Globe, it cannot now be affected to so great a Degree as it was then:—For by the confused Manner the Fragments were forced back again into the great Deep, Mountains were formed, which we may conjecture to be nearly equal in Height to the whole Thickness of the earthy Shell; and, it is probable, that some of these huge Fragments may reach as much below the Deep, or Waters within the earthy Shell, as the Hills and Mountains do on the Outside; and as is observed, have left innumerable and large Caverns and Fissures, which reach from the fiery Expansion within, to the Tops of our highest Mountains without; where many of them, in different Parts of the World, have Volcanos on their Tops, and therefrom discharge their *superfluous Fire*, as Occasion may require.—By these Vents, whenever the internal Expansion is arrived to a Strength sufficient to overcome the outward Pressure, it forces itself up through these Vents, and expands itself into the common Atmosphere without; but if it happens to make its Way into any of those Caverns, that have not the

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aforefaid Vent, it there diftends the incumbent *Strata*, and forms Earthquakes; and after it has found a Passage into the Atmosphere without, thefe Fragments are again forced together as before, but in a confufed Order.—Hence it may be obferved, that as foon as it arrives at a certain Force, it then fpreads itfelf, and the *Equilibrium* is again reftored.

Thus, as has been remarked, there will be left an internal *Void* of Space nearly 8000 Miles Diameter; which, from the above Obfervations, may be fupposed to contain Fire and inflammable Air, and Steam.—Hence, this terraqueous Globe will be of no greater *Specifick Gravity* than the *Ethers* wherein it is placed; and that this is fo, is confirmed by the Alterations made on the Flux and Reflux of the Sea into the Abyfs; and this *only* by the Moon's intercepting the Prefsure from the Extremities; fo that this terraqueous Globe will be carried round the Sun, (and not fall into it) in the fame Manner as Clouds, or in particular a Balloon, which is
kept

kept suspended at such a particular Distance from the Earth, viz. till its *Specifick Gravity* is altered, either by throwing out Ballast, to lessen that Gravity, and make it ascend higher, or by letting out some of the inflammable Air, and thereby increasing its Gravity.—If neither of these are done, or happens, by Accident or otherwise, the Balloon will continue at the same Height from the Earth, and be carried by the Current of Air wherein it swims, either North, South, East, or West; as that Current goes.—Heat and Cold are now allowed by all to be the Cause of the Current of Air we call Wind!—And what is very remarkable, the Person therein, let him be carried ever so fast, feels very little Effect from it.

Now it may be asked how is this Fire supported? If it does not receive some *Pabulum*, it must lose its Strength!—Certainly!—But it receives this Support by *Circulation* from without; as the Sun does by the *cold Ether* pressing into it from the Extremities of the System. — For the expansive Power from within

within the Shell of the Earth, may be observed to be in an exact *Equilibrium* with the compressive Power without.—For it has been often observed by Navigators, that at particular Places in the Ocean, there are certain *Gulfs* by which the Sea communicates with the *great Deep* below the Earth, particularly that Whirpool called *Maelftroom*, or *Navel of the Sea*, upon the Coast of Norway, where, says *Gordon*, in his *Geographical Grammar*,
 “ The Sea, for upwards of two Leagues round,
 “ makes such a terrible *Vortex*, that the Force
 “ and Indraught of the Water, together *with*
 “ *the Noise* and Tumbling of the Waves upon
 “ one another, is rather to be admired than
 “ expressed.—But, as in the Time of Flood,
 “ the Water is drawn in with a mighty
 “ Force, so during the Time of Ebb, does
 “ it throw out the Sea with such Violence,
 “ that the heaviest Bodies then cast into it,
 “ cannot sink, but are tossed back again by
 “ the impetuous Stream which rusheth out
 “ with incredible Force.”—Hence may be observed, that there is a continual Circulation, or alternate *Flux* and *Reflux*, between the
 Seas,

Seas, without the earthy Shell, and the *Abyfs* within; and that the *expansive* Force within is in so exact an *Equilibrium* with the *Compression* without, that no greater Force is required to cause this Flux and Reflux, than the Difference the Moon makes by her intercepting some of the Pressure from the Extremities, when she is either over, or at a great Distance from the Part.—Now the Waters, in running into the Abyfs, carry with them Air enough for the *Pabulum*, or Support of the internal Fire.—On the Return of the Waters to the Expansion within the earthy Shell, they are again, by the Fire there, expanded into Vapour, which Vapour is forced up through the Caverns and Fissures from below, to the Tops of the highest Mountains, where by the Cold it there meets with, is again condensed into Water, falls into the different Cavities of the Earth, and is forced out in Springs, from thence into Rivers, and thence into the Sea.—Thus, as the Preacher tells us, “ *All the Rivers run into the Sea, yet the Sea is not full: Unto the Place from whence*

whence the Rivers come, thither they return again." (f)

It gives me Satisfaction to find that the Scriptures confirm the above natural Observations, and that they speak physically true concerning them.—Thus Job tells us (t) "*That the Earth is suspended on the constricting Mixture of Ethers*; the Place in the Heavens where these two ethereal Agents are in a just Proportion to each other, and of the same specifick Gravity with the Body of the Earth;

(f) Ecclef. I. 6.—(t) Job, XXVI. 7.

(t) What I have translated the *constricting Mixture* of the Ethers, in the English Bible is translated *Nothing*, but that cannot be the Signification of this Word: It is BaLiMaH, from BaLaM, which according to all Lexicons, signifies *to constrict, to bind, to restrain*, as the Violence of an Horse or Ass is by a Bridle; and is to be found but once more in the Bible, which is Psalm XXXII. 9, where it is made use of as a participle passive, for the restraining an Horse or Ass with a Bridle;—without the final *Mem*, it is often made use of as a *Mixture* of different Things, as dry and wet, &c.—It is probable that the English Translators were led into this Error, by following the Latin Translation too closely; which at that Time, was by many of the Church of Rome believed to be more infallibly true than the original Hebrew.

Earth; in which the terraqueous Globe is carried on in them, with as much Ease as a Cork is on the Water, or as if the whole Body was composed of Ethers; having neither *Projection* nor *Gravity*.—Hence, notwithstanding the terraqueous Globe is carried on by these Ethers, at the incredible Rate of more than one thousand Miles every Hour; yet the Inhabitants on it meet neither with Resistance or Pressure from these Ethers, and therefore find Nothing of this almost *inconceivable* quick Motion.—Much the same Thing has been observed by those who have been carried with the greatest Celerity in a Balloon; not finding any Thing of the Quickness of the Motion, or how it went.—*These Ethers compose the Swadling Band that surround it: (u) These are the Pillars which support it; (v) when he gave his Decree that the Sea should not pass his Command. (w)*

Having now been forced to write a long Letter, in order to explain my Conjectures about the internal Make of this terraqueous
Globe,

(u) Job, XXXVIII, 9.—(v) Job, IX, 6.—(w) Prov. VIII, 27, 28, 29.

Globe, I shall defer pointing out the Agents Nature makes Use of, and the Method they act by, in order to carry on the diurnal Rotation, and the annual Revolution, to my next Letter, which you will receive soon.

Adieu,

F. PENROSE.

STONEHOUSE,

Oct. 18, 1785.

TO JOHN HEAVISIDE, Esq.

Mr. Heaviside's Question, "*Why does not the Earth gravitate into the Sun, &c.*" answered.—*All Space filled with ETHERS, which reach from the Sun, to the Extremities of this System, and are in continual Conflict, and cause a vibrating Motion, by their Endeavour of getting the better of each other. These Ethers the Cause of Projection and Gravity.—The Earth and Planets of different specifick Gravities, according to their Distance from the Sun.—The diurnal and annual Motion of the Earth accounted for. The Phenomena of Nature, and the Scriptures, confirm the Testimony of each other.*

DEAR SIR,

IN the last Letter, I sent you my Conjectures on the Make and Form of this terraqueous Globe; by which you may observe, that I suppose the Thickness of the earthy Shell to be but small, in Comparison with the inter-

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nal *Void* or *Hollow* in the *Midst* of it.—By the *Phenomena* of Earthquakes, &c. it appears that this Hollow is filled with Fire, inflammable Air, and Steam. — Thus the whole Body of the terraqueous Globe will be of no greater specifick Gravity, than the Ethers which surround it.—If this was not the Case, and it was solid to the Centre, it seems probable that it would be forced into the Sun: But, as it is of the same specifick Gravity with the surrounding Ethers, they keep it at the same Distance from the Sun, and it swims therein with as much Ease as a Balloon does in the Air, above the Earth.

Having mentioned thus much, I shall now endeavour to answer the two Questions you were so anxious about, which you proposed in your Letter dated May 16; and again repeated in your last.—First, “ If the Earth,
 “ &c. were put in Motion by the Heat of
 “ the Sun, rarefying the Atmosphere between
 “ these Bodies, why did the Earth not im-
 “ mediately gravitate into the Sun, as the
 “ Medium must be there more rarefied than
 “ any

“ any where else ? ”—Secondly, “ What is
 “ the Impulse or trajectile Force for its an-
 “ nual Motion ; and then, what is the Power
 “ that brings it back again from the immense
 “ Distance at which it is at the Summer
 “ Solstice ; or prevent it from flying off in a
 “ Tangent ? ”

In some of my former Letters ^(x) I observed
 it was the Opinion of the ancient Philoso-
 phers, that the Heavens were filled with Fire
 or Light and Air, and that these were the
 Agents which governed all other Things :
 Sir Isaac Newton seems to think so too, ^(y) for
 he supposed “ that Light and Ether lay hid
 “ in *all* Bodies ; that the *Light proceeded from*
 “ *the Sun*, and the *Spirit from the Extremities!*
 “ That if their elastic Force were expanded
 “ through the whole Heavens ; and that if
 “ this Medium be rarer at the Body of the
 “ Sun, than at its Surface, and rarer at the
 “ Surface, than at the hundredth Part of an
 “ Inch from the Body of the Sun ; and rarer
 “ there than at the fiftieth Part of an Inch
 “ from

(x) Letter IV. Introduction, P. 60.—(y) Opt. P. 324, 325.

“ from its Body; and rarer at this Place,
 “ than at the Orb of Saturn; I see no Reason,
 “ fon, (says he) why the Increase of its Density
 “ should stop any where, and not rather
 “ be continued through all the Distances, from
 “ the Sun to Saturn, and beyond.—Then, if
 “ we suppose two vibrating Mediums, the
 “ one rarer at the dense Bodies of the Sun,
 “ Stars, Planets, and Comets, than in the
 “ celestial Spaces between them; so that if
 “ the elastic Force of this Medium may be
 “ exceeding great, it may suffice to *impel*
 “ Bodies *from the denser Parts of the Medium,*
 “ *towards the rarer, with all that Force or*
 “ *Impulse which we call Gravity.*

Hence we find, that it was the Opinion of
 Sir Isaac Newton, and the ancient Philosophers,
 that there was an ethereal Fluid, which filled
all Space, from the Sun to the Extremities of
 this System.—That what issued from the Sun,
 in Form of Light, was more rare than that
 which was returned from the Extremities to
 the Sun, which he calls Spirit.—By these Agents,
 (the ETHERS)

all

all Motion was performed, and by the Spirit, every Thing was forced to the Sun, with that Power we call *Gravity*.—That the *Mixture* of these two Ethiers was of a different specifick Gravity, in Proportion as one or other abounded.—Hence, that the Bodies of the Earth, Planets, &c. circulating round the Sun, must be of different specifick Gravities, agreeing exactly with the specifick Gravity of the Medium (*Mixture*,) wherein they were placed.

Thus the Earth must be of less specifick Gravity than *Venus*; *Venus* than *Jupiter*, &c. This may be explained so far, as to understand my Meaning, by placing a Glass or Metal Bubble, of the exact specifick Gravity, between Water and Spirit of Wine —If we place this Bubble at the Bottom of a Glass Tube, and pour on it an Inch of Spirit of Wine, it will be forced and kept at Bottom by its own Gravity; if we add an Inch of Water, it will then remain at Rest, in any Part of the Fluid:—If we again add another Inch of Water by Degrees, we shall perceive,

perceive, that the Fluid, by this Means, will acquire a greater specifick Gravity than the Bubble, and will then, (according to the Laws of Hydrostaticks,) be forced, *by Gravity*, down to the Bottom, and will then force the Bubble of less specifick Gravity, to ascend to the Top.—This Motion of the Bubble in the Fluid, may be made to move or change its Place, in the same Manner by Heat and Cold. Thus by applying Heat to the Top, or any Side of the Fluid, it will expand its Parts, and thereby make it to occupy more Space: Hence its Pores being filled with Heat or Fire, it will resist less, and the cold and dense Parts of the Fluid will press it towards, and into that Part which is more rare, and of less specifick Gravity, and resists less.—Hence we may observe, that Gravity and Levity are relative Effects.

Thus, the Earth being of the same specifick Gravity, with the *Mixture* of the surrounding Ethers; these Ethers keep it at the same Distance it is from the Sun, and prevent it being projected farther from the Sun, or forced nearer to it, Having

Having observed thus much, that the Ascent from the Sun, and the Descent to it, are occasioned by the Rarity and Density of the different Mediums, as the different Mixtures of the Ethers, between the Sun and the Extremities, according as the Quantity of either one prevails; I shall now endeavour to point out the Causes of the *diurnal* and *annual* Motions of the Earth; but before I do this, let it be remembered, that Bodies of different Densities, are a longer or a shorter Time heating, and also that they retain their Heat a longer or a shorter Time, according to their Densities. ⁽²⁾—Thus, Water will acquire a greater Heat than Air, and Earth than Water, &c.—This is observed to be the Cause of different Winds; for it is a known and invariable Quality of the Air, for the Cold to endeavour to force out the Hot, and the Hot to open and expand the Cold.—Thus the Earth being denser than Water, it will acquire a greater Heat than the Sea.—“ It is observed, that the Sea Breezes blow “ towards the Land, in the Middle Part of “ the

(2) See Let. V. P. 181, 189.

“ the Day, in *every Direction*; and in the
 “ Middle or coldest Part of the Night, the
 “ Land Breezes blow towards the Sea, and
 “ thus alternately they succeed each other.—
 “ Hence the Equilibrium of the Pressure of
 “ the two Atmospheres being destroyed, and
 “ the Land Atmosphere, by the Heat being
 “ rendered specifically lighter than the Air at
 “ Sea, the former ascends by the superior
 “ Pressure or Weight of the latter; therefore
 “ the Sea Breezes *blow towards the Land, in*
 “ *every possible Direction*.—When Night comes
 “ on, the Sun’s Heat abates, until the Land
 “ Atmosphere becomes equally dense with
 “ that at Sea.—The Equilibrium of Pressure
 “ being thus restored, the Sea Breezes totally
 “ cease.—Thus, Cold increasing by the Ab-
 “ sence of the Sun, and its sudden Departure
 “ below the Horizon, accumulates on the
 “ Surface of the Islands, and condenses their
 “ incumbent Atmosphere more than that at
 “ Sea.”

I shall now apply Deductions from the
 Phenomena observed, and by them I shall en-
 deavour

deavour to explain the Motions of this teraqueous Globe.—First then, I suppose, there is a *hot Ether* or Light continually issuing from the Sun at the Centre, which is the Cause of *Projection*, Rarefaction, Expansion, and what we call a *centrifugal Force*, &c. and a *cold Ether* or Spirit continually descending from the Extremities of this System, to the Sun at the Centre, which is the Cause of Attraction, Cohesion, Pressure, *Gravity*, and what is called a *centripetal Force*.

Thus, Light or one Moiety of the celestial Ethers, (which is the rarer or finer Part,) is in continual Motion, from the Sun to the Circumference; and the other Moiety or *Spirit*, (which is the grosser Part,) is in continual Motion from the Circumference or Extremities of this System, to the Sun in the Centre;—that these two Forces, by Mixture, exactly balance each other at the Morning and Evening Edge of the Earth, and parallel with the Ecliptic.—The Motion of these adverse Forces causes an Expansion, and lays a Stress or Pressure on every Body, and every

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Particle of the ethereal Fluid, (and is the Cause of Cohesion,) and forces the Bodies contained therein, either nearer or farther from the Sun, according as the different Mixture of these two Particles prevail, and the specific Gravity of the Body.—Thus, when an Equilibrium is formed round that Body, it remains at Rest, and continues so, till by Light or Heat an Expansion is made on one Side, or Part of it; when Motion ensues, and continues so long as the Pressure behind is of greater Force than the Projection or Expansion before.

The Mixture of these two Qualities of Ethers, being rarer or denser in Proportion to the Distance between the Sun, and the Extremities of the System.—Thus the Bodies of the Earth, and all the Planets, are formed of different specifick Gravities, according as they are placed either nearer or farther off from the Sun, and are placed in a *Mixture* of Ethers, of the same specifick Gravity with the Planets placed therein; and are thereby prevented from approaching nearer, or receding

ceding farther from him.—Thus the Light projecting on one Side of the terraqueous Globe, and Spirit pressing in at the opposite, causes the Earth's Motion round its Axis, in the same Manner as a Cork or Piece of Wood may be observed to circulate round, when a River is obstructed by a Bank, and the Water made to circulate round.

We will now suppose the Sun to be placed in the Firmament or Expansion, and the Earth in the same Place it now occupies; I will then suppose, (as Moses informs us) that it was first made to turn on its Axis by the immediate Power of God; after that, having finished his Work, it was an *Automaton*, and he saw that it was good, and every Part of it capable to perform the Office he designed it for.—Thus he left *Nature*, or the *material* Agents, to perform their own Work; *unless, by a Miracle*, he stopped or altered them, to shew his Power over them.—Thus, as has been observed, the *projectile Force* of the Light from the Sun, on that Side of the Earth opposite to it, was exactly counterbalanced

counterbalanced by the *gravitating Force* of the Spirit on the Backside of the Earth, opposite to the Extremities.—Now, it is well known, and has already been observed, that Bodies receive and retain their Heat, in Proportion to their Denfities, and that this has been proved to be the Cause of Winds, Hurricanes, &c.—Thus, that Side of the terraqueous Globe, opposite the Sun, having its Parts greatly heated, and being more than one thousand Times more dense than the Atmosphere, it retains it a great While longer ;—Thus, the Atmosphere at the Evening Edge of the Earth, is more rarefied and expanded by this Heat, and the dense Air or Spirit pressing in from behind, (and also from that Side opposite the Extremities) to form an Equilibrium, forces it round its Centre, towards the Morning Edge, or from West to East.—Hence the diurnal Motion ;—the lateral Rarefaction being greater on this Quarter from Noon to Evening, or between South and West, than on its opposite, receives a different Impulse, in a *Diagonal* of these two Forces, viz. that of the projectile, on that Side the Earth

Earth next the Sun, and the gravitating, on that Side opposite the Extremities.—Hence, the annual Impulse through the Ecliptick, which makes an Angle of 23 D. 30 M. with the diurnal; and as these Forces are continually acting, so the Earth will continue her Motion round her Axis, from West to East, together with that through the Ecliptick;—As these Ethers are of different Qualities, both nearer or farther from the Sun; and as the terraqueous Globe is exactly of the same specifick Gravity with this Mixture of the Ethers, wherein she is placed, (which is in a continual Current or Circulation round the Sun,) so must the Earth be carried round the Sun with it.

We may form some Conception how these two opposite Forces act by the Motions of a Pendulum, or a Weight suspended by an inflexible Rod on a Pin, as its Centre of Motion.—“ Its Weight or Gravity will hinder
 “ its approaching any nearer to the Centre,
 “ and the Rod or Projection will prevent its
 “ Weight or Gravity from carrying it farther
 “ from the Centre; but, nevertheless, it is
 “ capable

“capable of being put in Motion by a *small*
 “*lateral* Impulse, and will describe not a
 “strait Line, but *Arcs* of a Circle, whose
 “Centre is the Pin from whence it is sus-
 “pended.—And as the two Forces are sup-
 “posed equal, the Case of the Earth will be
 “exactly analogous to that of the Pendulum!”

Thus the progressive or lateral Impulse being always exerted in the Direction of the Plane of the Earth's enlightened Hemisphere, where the mixt Force of these conflicting Ethers is equal, and Resistance nothing.—Which Plane is always perpendicular to the Rays drawn from the Sun to that Place.—If in any Part of the Earth's Orbit, the *Pressure or Gravity* be greater than ordinary, or *the Projection of the Light* less; the Earth, in either Case, will be made to approach in that Part of its Orbit, nearer to the Sun: Or, if the *lateral* Impulse be stronger or weaker than ordinary, the Earth will be forced farther off, or nearer to the Sun: And as the Moon and Planets are sometimes so situated, that if, by the Intervention of their Bodies,
 they

they interrupt the Action of *Spirit* or *Light*; this Interruption may lessen or increase their Force, either to bring the Earth nearer to, or farther from the Sun. — Witness the Moon's Influence on the Tides!

The foregoing Account of the Phenomena of Nature, seems to confirm and explain to us the short Hints thereof given in the Scriptures,

I shall therefore submit to your Judgement and Candour, whether what I have said may not illustrate the Mosaic Account of the Formation of the Earth, and Reformation of it, at the Deluge; and then conclude, that as the Phenomena of Nature, Reason, and Revelation so perfectly agree, whether that Coincidence may not be considered as a Testimony of the Truth of each.

Thus we are informed, that the all-wise Creator has observed the most exact Proportions, and has made ALL Things in *Number*, *Weight*, and *Measure*:—Who made *Weight*
for

for the *Winds* or, (which is more literal) *who made the Spirit the gravitating Instrument, and weighed the Waters by Measure.* ^(a) Who hath measured the Waters in the Hollow of his Hand; and meted (or spread) out the Heavens with a Span, and comprehended the Dust of the Earth in a *Measure*;—who *weighed* the Mountains in Scales, and the Hills in a Balance. ^(b) “Who hath *bound the Waters* in a *Garment*; who hath established all the Ends of the Earth: ^(c) Who shut up the Sea with Doors, and made the Cloud the Garment thereof, and thick Darkness a Swadling-Band for it; and said hitherto shalt thou come, but no farther; and here shall thy proud Waves be stayed. ^(d) The North declines, (or *gravitates*) to the empty Place, (or South) and hangeth the Earth upon Nothing, (in Hebrew) (the *Mixture of Ethers,*) ^(e) These, as we are informed, ^(f) are the *Pillars* of the Earth, and the Lord has set the *World* upon them.

Adieu,

F. PENROSE.

STONEHOUSE,

Oct. 20, 1785.

(a) Job, XXVIII. 25.—(b) Isaiah, XL. 12.—(c) Proverbs. XXX. 4.—(d) Job, XXXVIII. 8, 9, 10, 11.—(e) Job, XXVI. 7.—(f) I. Sam. II. 8.

TO JOHN HEAVISIDE, Esq.

DEAR SIR,

IN your last Letter, you were so complaisant as to assure me, that my long Letters gave you infinite Pleasure, and that I had not answered your former Questions.—In my two last, I endeavoured to do it in as clear a Manner as I could ; I hope they will find your Health quite restored, by your Journey into Norfolk and Suffolk, together with your Sea Bathing.

I herewith send you a New Year's Gift, for A. D. 1786, in Hopes to profit by the Remarks of yourself and Friends.

It is two Diagrams, (an original Design of my own) constructed to shew the Places of the Sun and Moon, for every Day next Year, according to the Julian Calendar.—You will find some Part of it to differ from what is generally taught in Astronomical Lectures, and received as true, viz. the Division of the

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Ecliptick

Ecliptick, and the Precession of the Equinoxes, but these appear to me contrary to the Operations or Laws of Nature; I therefore wish to have them examined by Persons well versed in these Sciences; and as the Improvement of Knowledge is the sole End of my Design, so if you will send me the critical Remarks of your Mathematical Friends thereon, I doubt not but all these Difficulties will be cleared up.

I am,

DEAR SIR,

Your faithful

And obliged Friend,

F. PENROSE.

STONEHOUSE,

Dec. 26, 1788.

TO F. PENROSE, Esq.

The Observations of Mr. Heavyside's astronomical Friend, on Mr. Penrose's Diagrams, not conclusive.

DEAR SIR,

YOUR last Favour found me very early in the new Year at Potterels, where I had been for two Months, so far from well, as not to have stired out of Doors hardly in all that Time. My little Excursion into Norfolk and Suffolk, was of some Service to me for a While, but I soon grew worse again, and was unable to stir; indeed I have not been able to ride ten Miles on Horseback, in any one Day, for near a Year and Half past; however, I have been recovering full as fast as I can expect, for the last five or six Weeks, and have got up my Flesh and Strength again amazingly, if I can but keep free from Colds, to oppress my Lungs, which are still in a Situation too susceptible of Injury.—This State of Health has deterred me
from

from staying in London more than a Day or two at a Time, when Business obliged me to it, till very lately; when, upon Trial, I found myself, thank God, equal to staying here without Prejudice.—For these Reasons I had no Opportunity till very lately of shewing your Diagrams, (with which you favoured me, and for which I think myself very highly obliged to you) to any of my learned Friends; but I do assure you, that I did not neglect the very first I had; and this very Day the Gentleman called, when I was out, and left it for me, with a Note, of which you will find a Copy in the Margin; I would have sent the Note itself, but that it would have made it a double Letter.

As I do not think he has entered so deeply into this Business as he should have done, I am by no Means satisfied with the little he has said, and therefore shall endeavour to find out some other Astronomer, who will give it more Consideration than I fear he has done; I should therefore have deferred writing till then, but that as I think it probable you may wish

wish to have the Plate engraved soon; I trouble you now, to beg you will give me your immediate Directions for having it done, if you wish to have it done *now*, and I will use my best Endeavours to find out a good Engraver.—Pray what think you of this Gentleman's Idea on that Subject?

On the other Side you will likewise find what my Friend Dr. Alexander, (to whom I wrote some Time ago, to get some Experiments made relative to the Weight of Bodies at different Depths in Mines,) says on that Head: His Account seems in some Measure to contradict your Opinion as well as my own.—If you are not satisfied with this Answer, and would put any more particular Questions to him, pray send them to me, and I will endeavour to procure an Answer to them; for it will give me great Pleasure to procure you any Information or Satisfaction in your laudable Pursuits after Knowledge and Philosophy.—Nor would I have you think, that because I am too idle a Fellow myself, to apply closely to the Study of Philosophy

Iosophy as you do, that therefore I take no Pleasure in such Enquiries; far otherwise; I really have great Pleasure in it, and should follow the Pursuit closely had I Leisure, and any Friend near me to assist or join me in it.

The astronomical Gentleman who had the Examination of your Diagrams, presents his Compliments, and has returned it, and observes, that “ He fears some of the Positions “ it contains will not be found to have been “ corrected up to the latest Discoveries, or “ *rather newest Opinions.*”

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

Feb. 22, 1786.

TO JOHN HEAVISIDE, Esq.

DEAR SIR,

YOUR last very kind and obliging Letter came to Stonehouse when I was in Cornwall, where I had been a great Part of the Months of February and March:—For this last Month I have been confined with the Gout:—I thank God, I am now able to walk again.—It gave us very sincere Pleasure to be informed, that you were recovered from your late Indisposition.

I am greatly obliged to you for the Trouble you have taken, in consulting your Astronomical Friends, about my Diagrams.—As I differ therein from what is generally taught by Astronomers, about the Division of the Ecliptick, the Precession of the Equinoxes, which appear to me to be Things of great Importance, I did hope that they would have thought it a Matter worthy their Examination, and that I should be confirmed either that I was right, or that my Errors, if any, would

would be pointed out and corrected.—I therefore join entirely in your Opinion concerning it, viz. that they have not entered so deeply into the Business as I could have wished they had done.—For, as they observe, “*the Positions therein differ from the latest Discoveries, or rather the newest Opinions.*” For that Reason I wished to have them thoroughly examined, as Truth is my Object.

If you have not yet met with an Astronomer, whose Opinion may be depended on, I hope, from your great Acquaintance, you soon will have an Opportunity of doing it.—I have sent one of these Diagrams to Oxford, with a Desire that it might be examined by the Geometricians and Astronomers there, but I have not yet received any Intelligence concerning it.—I am afraid that many Teachers of Science go on by Rote, with the same String of Experiments and Arguments that they have been taught, without giving themselves Freedom and Trouble to examine the Truth of them.

I give you and Dr. Alexander many Thanks for the Intelligence he sent you, concerning the Rise and Fall of the Mercury in the Barometer, when under the Earth.—I am afraid that Dr. Alexander, by consulting Miners, who *had the Rudiments of Philosophy*, has answered the Inquiry from Theory and not from Experiment.—All Experience tell us, that the deeper we dig under the Surface of the Earth, the Heat is the greater, and of Consequence the Air is the rarer;—therefore, for that Reason, I am fearful that those Persons, whom Dr. Alexander applied to, have imposed on him, and answered his Queries from the Ideas they had of the Matter, and *not* from Experiment.—If they had made Use of a Thermometer, instead of a Barometer, I believe their Theory would prove true.—I could only wish for an Experiment without Theory.—Let a Barometer be carried down into a Mine, mark the Height of the Quicksilver on the Surface of the Ground, and also every thirty or forty Fathom you descend.—If they had also a Quicksilver Thermometer, and likewise mark the different Heights of

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the Mercury, it would be more satisfactory. I am sorry that you and Dr. Alexander should have had so much Trouble, and that he should have met with so many Difficulties about it.—All this I can most readily believe, as I have met with the same.—It might be imagined that I could get a Thing of this Kind easily done in Cornwall.—I have applied to many of my Acquaintance for that Purpose, and told them that I should be glad to pay a Man for his Trouble in doing it.—I have been often promised it, but have never yet been able to get it performed.—If I could go down in a Mine myself, I could easily get it done! A Gentleman, when I was last in Cornwall, promised me to get it done, but I am fearful it will be some Time before it will be brought about.

I am,

DEAR SIR,

Your obliged and faithful Servant,

F. PENROSE.

STONEHOUSE,

April 10, 1786.

TO F. PENROSE, Esq.

DEAR SIR,

I AM ashamed to see that it is now six Weeks since I was favoured with your very kind Letter, and that I cannot even now answer it satisfactorily, either to myself or to you; for having been so much out of Town, (in which I dare not stay long at a Time, on Account of my Cough,) and having had so very much to do when I am here, and now finding that *real* deep Philosophers and Astronomers are much more thinly sown than I apprehended, I have not been able to get at any one who has ventured to give me any *decided* Opinion upon your Diagrams. — I want much to get them shewn to Dr. Maskelyne, but have not yet been so lucky as to meet with one Acquaintance of mine that knows him enough to do it; however, I do not yet despair of finding such a one, if your Friends at Oxford fail you.

I have wrote again to my Friend, Dr. Alexander,

exander, to try if he can procure a more exact Experiment to be made with a Barometer, in a Coal-Pit; which I dare say he will do if he can; but I need not tell you how difficult it is to put those Miners, (or indeed any Body else) out of the Way in which they have been used to tread, unless it were possible to impress them with a Desire of real Knowledge, unadulterated with Prejudice, *or make it* their Interest.

I am,

DEAR SIR,

Very truly,

Your Friend, and obedient Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

June 29, 1786.

On the MOON and LUNAR MOTIONS.

TO JOHN HEAVISIDE, Esq.

The Moon not a Planet, but a Satellite attending the Earth.—The recorded Observations of Astronomers, concerning Her, collected.—Her Make and Motions described. — The Chaldean Cycle, with the Methods they made use of for calculating their Eclipses.—The physical Causes of these Motions explained, and confirmed by the Observations of Mr. Herschel, and the French Astronomers.

DEAR SIR,

I GIVE you many Thanks for the Trouble you have taken to get a decided Opinion on my Diagrams, &c.—As you express a Hope, in your last Letter, to get Dr. Maskelyne's Opinion on them, I have herewith sent you my Theory on the Moon, and the lunar Motions, in Hopes that you may, at the same Time, get his Sentiments on the
lunar

On the MOON and LUNAR MOTIONS.

lunar Motions also, and perhaps he will let you know what Objections he has to any of them.

The lunar Motions are called irregular; but, on Examination, we shall find no Irregularity belonging to the Moon or her Motions, but all of them performed according to the most exact and perfect Harmony and Mechanism; and that their apparent Intricacy proceeds from our Incapacity to comprehend their almost innumerable Variety of Motions. If we study them with a proper Attention, we shall find, that, instead of being irregular, they are performed with the greatest Harmony and Regularity, according to the most strict Laws of Geometry, Number, Weight, and Measure; and though their Number and Variety exceed the Power of comprehending them, or even of believing their Regularity, unless by those who make them their particular Study; for though the Moon requires 7,948,800 synodical Revolutions, (which are more than 600,000 Years) for to go through
all

On the MOON and LUNAR MOTIONS.

all her Variations, and finish her Period or Cycle; ^(g) yet all these various Motions are carried on in the most curious, exact, and mechanical Manner, according to Number, Weight, and Measure, and cannot be calculated or understood by no other Method; therefore if any Theory concerning them will not bear the Test of Geometry and Numbers, it must be discarded.—Having premised thus much, I shall, in the first Place, collect the recorded Facts and Observations of Astronomers concerning them; from which I shall endeavour to draw the most natural Inferences, to explain these various Motions, and to point out their physical Causes.

The Moon is not a Planet but a Satellite, attending the Earth; which, together with the Sun, are allowed to be the principal Cause of her Motions.—These Motions are generally divided in a three-fold Manner; which are not only connected with each other, but are also connected with those of the Earth's,

in

(g) Kennedy, P. 196, 210.

On the MOON and LUNAR MOTIONS.

in a most wonderful Manner.—In the first Place, she has a Motion round the Earth from Change to Change; or, from Sun to Sun, which she performs in 29 D. 12 H. 44 M. 1 S. 45 T. which is called a *Lunation*.—2dly, She has a forward Motion, compounded with this Lunation, from West to East, attending the Earth through the Ecliptick, round the Sun;—this she performs in twelve Lunations, 10 Days, 21 Hours, and 39 Seconds.—These twelve Lunations are called a *lunar Year*, and the 10 Days, 21 Hours, and 39 Seconds, are the Time required for her to get up with the Sun again. These 10 Days, 21 Hours, and 39 Seconds, are not dropt or lost, but go on as Part of the next Lunation, and is called *the Epact*, and is the Difference between the lunar and solar Year.—She does not keep the Earth's Path round the Sun, through the Ecliptick, but goes round the Earth in a progressive Circle, like a Screw, and forward, through the Ecliptick, at the same Time, together with
the

On the MOON and LUNAR MOTIONS.

the Earth ; always, (throughout her whole Orbit,) keeping nearly at the same Distance from Her ;—that is, Half the Diameter of her Orbit ; which is supposed to be about 240,000 Miles. — These Motions of the Moon in her Orbit, round the Earth, and through the Ecliptick, is so well described by Mr. *Ferguson*, in his *Astronomy*,^(h) that I shall take the Liberty to send it you, in his own Words.—“ The Moon’s absolute Motion (*says he*) from her Change, to her first Quarter, is so much *slower* than the Earth’s, “ that she falls 240 thousand Miles, (equal “ to the Semidiameter of her Orbit) behind “ the Earth, at her first Quarter ; that is, “ she *falls back* a Space equal to her Distance “ from the Earth :—From that Time, her “ Motion is *gradually accelerated* to her Opposition or Full, and then she is come up “ as far as the Earth ; having *regained* what “ she *lost* in her first Quarter.—From the “ Full to the last Quarter, her Motion *con-*

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“ *tinues*^(h) *Ferguson*, P. 194, S. 267.

On the MOON and LUNAR MOTIONS.

“ *times accelerated*, so as to be just as far *before the Earth*, (at her third Quarter) as she was *behind* it at her *first*; but from thence to her Change, her Motion is *retarded*, so that she loses as much, with Respect to the Earth, as is equal to her Distance from it, or to the Semidiameter of her Orbit; and by that Means she comes in Conjunction (at the Change) as seen from the Earth.”

These Motions of the Moon, both round the Earth and round the Sun, are performed from West to East, and from Left to Right, in the same Manner as the Earth goes round the Sun:—But, besides these two *joint* Motions of the Moon, there is a Motion or an *ecliptick Current* of Ethers, *absolutely* belonging to the Moon.—This *Current of Ethers* goes also from West to East, as do the Earth and Moon, but with this Difference, that as the Earth and Moon proceed Eastward, from Left to Right; so this proceeds just in the opposite

On the MOON and LUNAR MOTIONS.

opposite Manner, from Right to Left, and may most properly be denominated *the Path of the Nodes or Eclipses*.—This also creeps round the Ecliptick in a progressive Circle, in 18 Years, 10 Days, 19 Hours, 46 Minutes, and 15 Seconds; when it again meets the Sun in the same Point of the Ecliptick, and then begins a new Cycle.—This was in Use in *Chaldea*, and is called the *Chaldean Cycle of Eclipses*:—For, in this Period, there will be a regular Return of the *same Eclipse* for many Ages; only the Eclipse get ¹28 ¹¹12 forward at every Return; and, by these slow Degrees, comes in at one Pole of the Earth, and after having passed quite over it, goes out at the other:—Thus those which come in at the North Pole, go out at the South; and those which come in at the South, go out at the North; after which they are again lost in the Expanse, but require more than one thousand Years to do it.—Hence it may be remarked, that the *Chaldeans*, (from amongst whom Abraham was called) had a
Method

On the MOON and LUNAR MOTIONS.

Method of calculating Eclipses ; for they had only to keep an Account of Number of Days and Years ; the Method the Patriarchs and Israelites were taught to calculate the Returns of the Weeks, Months, and Years, and to keep their Chronology. ⁽ⁱ⁾ Thus by *only numbering* and keeping an Account of the Days and Years of this *Chaldean Cycle*, which was finished every eighteen Years, and the same Eclipse was sure to make its Appearance again ; for at the End of every eighteen Years, the Sun, Moon, and Nodes meet the Earth on the same Point of the Ecliptick, and they then begin a new Cycle.—To illustrate this, I shall here add the Calculations of the fourth and fifth Return of that remarkable Eclipse which happened at London, May 3, N. S. 1715—at 9 H. 51 M. or 2 H. 9 M. before twelve o'Clock, when the astronomical Day is compleated, so that it was May 2 D. 21 H.

(i) Introduction, P. 27, 28.

On the MOON and LUNAR MOTIONS.

H. 51 M. substract this from the three Days of May, and it leaves D.H.M.

	28	2	9—1715	
To which add June	15	4	56—1787	the Eclipse
It makes in the Whole	43	7	5—72	Years, 43 D. 7 H. 5 M.
	Years D. H. M.			D. H. M.
4th—4 Cycles—	72	43	7 5—	June 15 4 56 P. M.— 1787
5th—1 Cycle—	18	10	19 46 15	June 26 0 42 15 P.M. 18
It makes in the Whole	90	54	2 51 15	1805

From the above Example we may observe with what Ease and Certainty the Chaldeans might calculate the Return of the Eclipses, viz. by knowing exactly the Length or Quantity of Time which the Sun, Moon, and Nodes require to perform their Circle, or to meet again in the same Point of the Ecliptick at which they parted; for though they do not meet precisely at the same Point, yet it wants only 28^I 12^{II}. — These Calculations make it appear, that the Nodes move forward to the Eastward as well as the Earth and Moon, and also that they move a contrary Way

On the MOON and LUNAR MOTIONS.

Way from them, and by that Means the Moon crosses them twice every Luration.

In this Cycle there are 223 Lunations

229 Nodes

And

18 Julian Years, 10 Days, 19 Hours,

46 Minutes, 15 T.

Hence the Regularity and the Harmony of the Sun, Moon, and Earth, may be remarked, and the Method of the Ancients in calculating their Eclipses, which they did in so *mechanical* a Manner, that they had no Occasion to know which of them moved, or whether any one of them did; yet were able to calculate, to prognosticate, or foretel these supposed portentous Events.

Thus, as has been observed, the ecliptick Path of the Eclipses, goes forward from West to East, but a contrary Way to the Earth and Moon, and makes an Angle of 5 Degrees 20 Minutes, with the ecliptick Path of the Earth.

The

On the MOON and LUNAR MOTIONS.

The Moon makes her Orbit round the Earth, by an Angle of 45 Degrees, with the Ecliptick;—but as this Angle is not the same throughout her whole Orbit, as the Moon, in one Part of her Orbit, is Half the Diameter of it *before* the Earth, and in another Part, so much behind her, so she does not make the same Angle with the Ecliptick quite through her Revolution. — Thus, at the Entrance into her *third* Quarter, she cuts the Ecliptick *diagonally*, and *slackens* her Motion two-thirds, (when she enters the South, or Summer Part of her Lunation,) and, (as was observed by Mr. Ferguson,) *falls back*, and proceeds to the Westward, by an Angle of 45 Degrees.—Thus she keeps on with this Angle, till she comes to the Change; when it is altered to the Complement of that Angle, which is also 45 Degrees; which Angle is continued from the Change to her *first* Quarter;—at which Point she crosses the Ecliptick, and enters the North or Winter Part of her Orbit.—Here this Angle
is

On the MOON and LUNAR MOTIONS.

is altered from 45 Degrees, to 19 Degrees, 50 Minutes, and her Motion is *increased* two-thirds, and she now recovers the Motion *she lost at her third Quarter*; and, by this Means, she gets so forward to the Eastward, in the Ecliptick, as to be exactly in a Line with the Earth and Sun at her Opposition. — From this Place she returns round the Earth, and continues her *accelerated* Motion, till she arrives again at her third Quarter, where she is again a Semi-diameter of her Orbit, *before the Earth*; and from this Place she goes on as above described.

The Moon's Orbit, round the Earth, is marked by Astronomers with four Divisions: The first is from Star to Star; which she performs in 27 Days, 7 Hours, 43 Minutes, 4 Seconds. — This would compleat her Orbit, did she not go forward in the Ecliptick at the same Time. — The second is from Apogee to Apogee, which requires 5 Hours, 35 Minutes, 39 Seconds more. — These 5 H. 35 M. 39 S.

On the MOON and LUNAR MOTIONS.

39 S. shew us how much her progressive Motion, forward, in the Ecliptick is, during the Time of her going from Apogee to Apogee.—The Earth's progressive Motion forward, through the Ecliptick, during one Rotation round her Axis, or twenty-four Hours, is four Minutes; hence, 1 H. 50 M. 12 S. belong to the Earth, and the remaining 3 H. 45 M. 27 S. is the Quantity of the Ecliptick *forward* Motion which belongs *absolutely* to the Moon during that Time.—Thus we may observe, that the Moon's absolute Motion *forward, through the Ecliptick*, is more than double to that of the Earth's.—This causes her to compleat her Orbit round the Sun, in less Time than the Earth does. This is also confirmed by the Motion of the Moon's Shadow over the Earth, during the Time of an Eclipse, which Mr. Ferguson tells us, ^(k) moves at the mean Rate of $30\frac{1}{2}$ Minutes of a Degree every Hour.—The third Division is from Node to Node.—This is not generally
 Z z distinguished

(k) Ferguson, P. 2-6. S. 338.

On the MOON and LUNAR MOTIONS.

distinguished in this Manner by Astronomers, as they have supposed that the Motion of the Nodes receded from East to West, and did not proceed forward, (as I do) from West to East, which requires 1 D. 4 H. 51 M. 8 S. 44 T. Time to compleat it, than from Apogee to Apogee.—The fourth Division wants 18 H. 34 M. 10 S. 1 T. to be added to the last, to bring the Moon to the Sun, or compleat the Lunation; which, as was before observed, is 29 D. 12 H. 44 M. 1 S. 45 T.

When the Moon comes to her Apogee, she has compleated her Orbit round the Earth, in the Ecliptick; but as the *ecliptick Current of Ethers*, (as they move forward in a progressive Circle) has got 1 D. 3 H. 51 M. 8 S. 44 T. before the Moon, during that Time, so it requires for the Moon to go just so much beyond her Orbit, to meet and cross it,—At the very Point, where the Moon, in her Orbit round the Earth, *crosses the ecliptick Current of Ethers*, is her Node, and a
Line

On the MOON and LUNAR MOTIONS.

Line from Node to Node, crossing the Centre of the Ecliptick, is called the *Line of Nodes*.—Thus the Line of Nodes crosses the Ecliptick every sixth Lunation, when the Node that was last in Conjunction with the Moon, *now* crosses the Ecliptick 4 D. 15 H. 25 M. before the Moon meets the Sun; and as the Nodes are diametrically opposite to each other, so this other Node wants the same Time to meet the Sun; but as the ecliptick Current of Ethers goes forward every Half a Node but 9 H. 17 M. 5 S. so the Moon comes in Conjunction only 9 H. 14 M. 5 S. after the Node.

The Nodes then cross each other, and change Places; the ascending one to the descending, and the descending to the ascending: Hence, whenever either Node at the End of the sixth Lunation, is 4 D. 15 H. 25 M. before the Moon, the other Node (being the same,) will meet the Moon in the Ecliptick, and cause a total and central Eclipse

On the MOON and LUNAR MOTIONS.

Eclipse.—But, as all these Points are of such different Lengths, and vary so much, it is not to be wondered at, that we have so few Eclipses; more especially, as the Orbit of the Moon is divided into 360 Degrees, and the Moon must pass the Node within 17 Degrees of it, at the Change, and within 12° at the Opposition, to cause an Eclipse; otherwise the Moon's Shadow will not touch the Earth, nor the Earth's Shadow the Moon.—In Order to make more clear what has been observed, I shall describe the Nodes and Eclipses for this Year, A. D. 1786.

The Nodes move forward so much faster, through the Ecliptick, than the Moon, that at the End of every twelfth Luration, that Node, which was in Conjunction with her, when she began her first, is got 9 D. 6 H. 50 M. 0 S. 12 T. before her; and just Half that Quantity, or 4 D. 15 H. 25 M. 0 S. 6 T. at the End of every sixth Luration.—The Nodes change Places every sixth Luration,

On the MOON and LUNAR MOTIONS.

tion, when the ascending Node becomes the descending, and the descending the ascending one.

Now to explain their Motion this Year.— We will suppose the two Nodes to be marked A and B —The Nodes crossed the Ecliptick Jan. 14 D. 12 H. 0 M. when A became the descending Node, and B the ascending one.—The Moon comes in Opposition to the Sun, 44 Minutes after, and causes a total Eclipse.—14 Days, 9 H. 5 M. after that, the other Node was in Conjunction with the Sun, and caused an Eclipse of that Luminary; after this, the Moon in her Orbit round the Earth, never crossed the ecliptick Path of the Nodes, *near enough* the Sun, to cause an Eclipse, till July 6, at 16 Minutes past twelve at Night, when the Node A will cross the Ecliptick 3 D. 15 H. 9 M. before the Moon was in Opposition; and, the other Node B will also want just as much to be in the Ecliptick, by that Means the Node B will

On the MOON and LUNAR MOTIONS.

will be in the Ecliptick, 54 Minutes only after the Moon is in Conjunction, and cause a total Eclipse of the Moon, July 11.—On the next Change, fourteen Days after, viz. July 25, the other Node A will meet the Moon in the Ecliptick, and cause an Eclipse of the Sun, and then will become the descending Node again.

The above are the collected Observations of Astronomers on the Moon, and the lunar Motions, from whence we may infer, that they are all caused and governed (as immortal Sir Isaac *Newton* has supposed) by the subtile *Ethers* with which the heavenly Space is filled, and by which they are surrounded.—For, according to him, “these *ETHERS* “are expanded through the whole Heavens, “and *impel* Bodies from the denser Parts of “of the Medium, towards the rarer, *with all* “that Force and *Impulse* which we call “GRAVITY. ⁽¹⁾ That these *Ethers* act in a “double Capacity, the one as *Light*, pro- “ceeding

(1) Let. IV. P. 163.

On the MOON and LUNAR MOTIONS.

“ceeding from the Sun, and the other as
“*Spirit*, descending towards the Sun;—and
“thus a *Circulation* is carried on between
“*these two vibrating Mediums*.”—Thus they
act by a continual Conflict, in a vibrating
Manner, with a Force in Proportion as the
one or the other prevail:—When the Light
prevails, it opens, expands, and projects
every Thing:—On the contrary, when the
Spirit prevails, every Thing is compressed,
and their Parts are forced in closer Contact.—
Thus all Bodies, by being compressed into
less Space, are increased in their specifick
Gravity, and they are also made to adhere
with all that Power or Force called Gravity,
Attraction of Cohesion, &c.

I think it must add to the Veneration we
have for the Scriptures, to find that they
speak justly in physical Matters, about the
Mechanism of Nature.—Thus Job tells us ^(m)
that God made a Weight for the Winds;
this

(m) Job. XXVIII, 25.

On the MOON and LUNAR MOTIONS.

this is according to our English Translation, but the Hebrew is more clear and expressive, it is there said that God made the *Wind* or *Spirit*, the *Instrument* of Gravity.

In the first Place, the Earth is carried through the Ecliptick, round the Sun, by a *Current of Ethers*, and the Moon, as a Satellite of the Earth, is carried round the Sun, through the Ecliptick with it.—The Moon has also a circular Motion of her own, round the Earth, which Motion intersects the ecliptick Motion by an Angle of 45 Degrees.

In Order to explain myself the better on these two Motions of the Moon, I shall instance the Sailing of a Ship, which is also affected, (*at the same Time,*) by two Forces, the Wind and the Tide, and her going forward is occasioned as either one or other prevail.—Thus, as the Sailors always observe the Ship is accelerated or retarded in her Sailing, according as she goes either with or against

On the MOON and LUNAR MOTIONS.

gainst the Tide, and that which ever of the two prevails, either the Wind or the Tide, so is the Ship carried on, either North or South; or, if both meet in an Angle, her Course is in a Diagonal between them; but if they meet exactly opposite to each other, both Forces are destroyed, and the Ship stands still in the same Place.—Hence, if a Ship receives a Force from the Wind, to sail two Miles an Hour, and the Current or Tide runs one Mile an Hour; this one Mile an Hour of the Current, ballances one Mile an Hour of the Force she receives from the Wind; so the Ship will loose the Force of one Mile an Hour in her sailing, and in Fact, will be found to proceed forward one Mile only.—On the contrary, let her turn back with the same Wind and Current, she will then go forward with the joint Forces of both; and will then proceed forward three Miles an Hour.—Much in the same Manner the Moon is carried round the Sun, through the Ecliptick, as a Satellite of the Earth to-

On the MOON and LUNAR MOTIONS.

gether with her; but as her *absolute* Force round the Earth is double to what carries the Earth round the Sun, and this Force or Current of Ethers which belongs to the Moon *only*, makes an Angle of forty-five Degrees, in crossing the Ecliptick: By this Means she is in one Part of her Orbit, round the Earth, Half of a Diameter of that Orbit, before the Earth, in the Ecliptick; and at another Part of her Orbit as much behind the Earth, and at her Conjunction and Opposition, exactly in a Line with it; always keeping nearly the same Distance from the Earth.—Thus being acted on *jointly* by both these Forces, when she comes to her third Quarter, she is then carried with an Angle of 45 Degrees, against the Current of Ethers which forces the Earth round the Sun, through the Ecliptick, and carries on the Earth four Minutes every twenty-four Hours, or a natural Day; which, as has been observed, is but Half the Force with which the Moon is carried round the Earth, so this ecliptick Current of Ethers
resists

On the MOON and LUNAR MOTIONS.

resists one Minute of that Force, and the Moon's absolute Motion forward, being resisted by one Minute out of two, so she proceeds but one Minute every six Hours, or ninety Degrees.—Hence it may be observed she loses a Moiety of her Force, and goes forward one only.—As soon as she comes in Conjunction with the Sun, she is then forced towards her first Quarter, by the Complement of the Angle she makes from her third Quarter to her Change.—This is also 45 Degrees; and, as she still continues to go *against* the ecliptick Current, she keeps that slow Pace, till she comes to the End of her first Quarter; at which Point she changes, and instead of going against, and being obstructed by the ecliptick Current, she receives its additional Force to carry her on.—Thus, as has been observed, her own Force carries her forward *two*, and the ecliptick Current *one*;—and instead of going with that slow Motion of one, which she did from her third Quarter to her first, she now goes three;
and

On the MOON and LUNAR MOTIONS.

and being a Semi-diameter of her Orbit, behind the Earth, occasioned by her *slow* Motion from her Change to this Place; so now, by her accelerated Motion, she recovers this second Quarter what she had lost in the first, and by that Means comes opposite to the Sun at her Full.—She, now by the same Means, continues the like *accelerated Motion*, till she arrives at her third Quarter, at the Entrance of which she goes on with her *slow* Motion as before.

The above Description of the Phenomena of the Moon's Motions, and the Conjectures how they are caused, seem to make it appear, that the Body of the Moon, and probably the Bodies of all the Planets, are formed much in the same Manner as this terraqueous Globe is described to be, ⁽ⁿ⁾ viz. of a thin Shell on the Outside, with a large Hollow or Void in the Midst, filled with Fire, Steam, or inflammable Air; and consequently of the same

(n) Let. XVI. XVII.

same specifick Gravity with the Ethers that surround them.—Thus the Moon is carried round the Earth by these Ethers, in the same Manner as the Earth is round the Sun; and by being exactly of the same specifick Gravity with these Ethers, *at the same Distance* she is placed from the Earth; she meets with no Resistance from them, but is carried on by and with them, with as much Ease as we see a Glass Bubble, of the same specifick Gravity with Water, will be carried on by it, never altering its Place, but goes with it in the same easy Manner as if it was a Part only of the Water; neither can she be moved nearer to the Earth:—As the expansive or projectile Power or Force of the Light, reflected from the Earth, prevents it; nor can she be carried farther from the Earth, as the compressing Power of the Spirit, from the Extremities, prevents it: — Which two Powers, by a joint Mixture, being of the same specifick Gravity with the Moon, she constantly moves in the same Direction that
these

On the MOON and LUNAR MOTIONS.

these do, and with as much Ease as a Balloon does.

Since this Letter was written, Mr. *Herschel's* Discoveries of the *Volcanos* in the Moon, confirm the above Conjectures to be true, and that the Body of the Moon is formed much in the same Manner as we have described the Earth to be; indeed it seems difficult to conceive how any large Body of Matter can be supported and constrained in the heavenly Spaces, by the surrounding Ethers, unless it is of the same specifick Gravity with them; and the only Method found or observed to do it, has been by filling their internal Void with Fire; by this Means a Body of Gold, or the heaviest Metal, may be made to be of so small specifick Gravity as to be forced to the greatest Distance from the Earth, by the surrounding Air.—Thus we find that all Nature is formed in a *mechanical* Manner, and relative to each other in *Number, Weight, and Measure*.—Hence, as has been already observed,

On the MOON and LUNAR MOTIONS.

observed, these Volcanos, both in the Earth and Moon, appear to be the most proper Method to regulate the Gravity of these Bodies, to the specifick Gravity of the surrounding Ethers.—These Vents being a Means, whenever the internal Expansion, *from the internal Fire*, becomes too great to throw off and discharge the superfluous Fire, and the remaining is condensed, much in the same Manner as may be observed in the Fire Engine; so that it never can arrive to such an Height as to destroy the Body, unless these Vents were effectually stopped. ^(o)

Mr *Baudy*, a Citizen of Geneva, a great and able Astronomer, has published a Letter against Mr. *Herschel's* Discoveries, wherein he has treated them as imaginary Visions, for says he, “ If within the Compass of his Telescope alone, he can count from 60 to 110
“ Stars, (Mr. *Pieter's* Assertion) that may
“ prove the Perfection of his Instrument, but
“ in

(o) P. 312.

On the MOON and LUNAR MOTIONS.

“ in a Zone of 15 Degrees in Length, and 2
“ in Breadth, could he have seen passing in
“ an Hour, 50,000? *so prodigious a Number*
“ could not be so easily nor so readily told!”
He then criticises these Discoveries in the
following Manner.— “ Mr. *Herschel*, (says
“ he,) a learned Astronomer, gives Scope to
“ his Imagination, but pays no Regard to the
“ Reality of his Experiments; for, (conti-
“ nues he,) by the exact Observations I have
“ taken the Pains to make and repeat, in dif-
“ ferent Climates of Europe, with excellent
“ Telescopes, I am sure that the most crowded
“ Parts of the *Heavens* cannot contain so
“ great a Number of Stars, united in the
“ Focus of the best Instrument whatever.—
“ Whenever the Sky is clear of all Kind of
“ Vapours, Stars are, or seem to be in Mo-
“ tion; so that their *continual Vibration* oc-
“ cupies the Eye in such a Manner, that the
“ Objects *multiply* in Proportion as you
“ count them.—*This is what generally de-*
“ *ceives those who trust too much to Appear-*
“ *ances!*

On the MOON and LUNAR MOTIONS.

“*ances!*—From those Illusions sprung the
 “ Idea of Volcanos in the Moon, *which would*
 “ *destroy the very Idea* of the Planet being in-
 “ habited as ours.”—Hence I observe, that not-
 withstanding the above judicious Remarks of
 so able an Astronomer as Mr. *Baudy* appears
 to be, yet, I think, with Regard to the *Vol-*
canos in the Moon, he should have tried his
 pre-conceived Idea *of the Moon being inhabited*
by the Matter of Fact only;—whether these
 were Volcanos or not?

Since the above Publication of Mr. Baudy,
 the French Astronomers appear to have as-
 certained the Certainty of the Fact; for in a
 Letter *M. De la Laude* has written in the
 Paris Journal, dated March 8, 1788, he ob-
 serves, that “ on the 13th Instant, from Se-
 “ ven to Nine in the Evening, *Dom. Novet,*
 “ one of the Astronomers of the Royal Ob-
 “ servatory, perceived in the unlightened Part
 “ of the Moon, what Mr. *Herschel* has called
 “ a Volcano, like a Star of the sixth Magni-
 3 B “ tude.

On the MOON and LUNAR MOTIONS.

“ tude, or one of the cloudy ones, the Bright-
“ ness of which increased, from Time to
“ Time, as by Flashes.—Other Astronomers
“ have perceived it, and Mr. *de Villeneuve*
“ had seen it before, on the 22d of May,
“ 1787.—We *cannot*, (says he) *therefore*
“ *doubt* of the Existance of this Volcano in
“ the Moon, Mr. *Herschel* saw it the 4th of
“ May, 1783, and particularly the 19th of
“ April, 1787.--In the Eclipse of the 24th
“ of June, 1778, *M. d’Ulloa*, a well-known
“ Spanish Astronomer, had seen on the dark
“ Disk of the Moon, a bright Point; and in
“ the total Eclipse of 1715, certain curious
“ Observers saw some Flashes of Lightning.
“ There is no sensible Atmosphere in the
“ Moon, it is true, and Chymists may dis-
“ pute about the Name of Volcanos being
“ given to *such apparent Eruption*; but the
“ Name after all is of no Consequence, and
“ we must certainly subscribe to Mr. *Herschel’s*
“ Opinion.—This Volcano is situated in the
“ North-east Part of the Moon, about three
“ Minutes

On the MOON and LUNAR MOTIONS.

“ Minutes from the Moon’s Border, towards
“ the Spot called Helicon, marked N^o. 12,
“ in the Figure of the Moon, in my Astro-
“ nomy.”

As I was desirous of sending you my Theory of the lunar Motions, it has occasioned my Letter to be of a greater Length than I proposed.—I had also a Design of sending you my Calculation of the Eclipse which is to happen on the 25th of this Month; but shall now send it you in a separate Letter next Week.

I am,

DEAR SIR,

Your Friend and Servant,

F. PENROSE.

STONEHOUSE,

July 5, 1786.

TO JOHN HEAVISIDE, Esq.

To confirm what Mr. Penrose has observed in his last and former Letters.—He has sent Mr. Heaviside a Calculation of the Eclipse which is to happen July the 25th.—It is calculated by the Method made use of by the Ancients, to measure and record Time:—But to shew how certain their Method was, it is also calculated according to the present, by Equations and Anomilies.—It may be remarked, that both these Methods differ from each other only 8 M. 11 S.—That the Patriarchs and Chaldeans had more Knowledge in Astronomy than is generally allowed them. This is proved by the 18 Years Cycle of Eclipses, and also the 19 Years Cycle of the Moon, both which, it is certain, we received from them, and without these Cycles, Astronomers would be at a great Loss.—Data on which the Calculations are made, and Conclusions infered from them.

DEAR SIR,

ACCORDING to Promise, I herewith
 A send you a Calculation of the Eclipse
 which

which will happen July 25; with a Recapitulation of some former Observations, to confirm what has been observed in my last and former Letters.—The ancient Patriarchs and the Chaldeans, measured their Time, and recorded Events, by the simple, easy, and natural Method of keeping an Account of the Days and Years.—That this Account might be remembered with the greatest Exactness, Moses tells us, God ordered the Sabbath Day, (or Cycle of seven Days) to be kept as a Festival, in Commemoration of the Creation, and to transmit to Posterity, an Account, that the Powers and Operations of the heavenly Bodies, were not eternal, nor inherent in them, but was given to them by Him.—And in Order to commemorate their Months, they were ordered to keep the *new*, or *first* Appearance of the Moon, as a Festival also; that, by this Means, it might not be forgot.—And that they should not mistake or forget when one Year or annual Revolution ended and another began, they were to keep the Feast of Ingathering, at the *End or Revolution* of the Year, *after* the Fruits of the

the Earth were ripe and gathered in. ^(p) — That this was the Method in Use about six hundred Years after the Flood, is most certain; for when Jacob was brought before Pharoah, Pharoah said unto him, "*how old art thou.*"—In the Margin of the Bible, there is a literal Translation of the Hebrew, "How many are *the Days of the Years* of thy Life. ^(q) Jacob answered in the same Style, "An hundred and thirty Years; few and evil have *the Days of the Years* of my Life been."—This shews us that it was the Method of Computation *then* in Use, both by the Patriarchs, and also by the Egyptians, who were supposed to be possessed of the greatest Learning.—After this, by some Means or other, Astronomers either dropt or lost this Method of measuring and keeping an Account by *Days and Years*; and since that Time, have made their Calculations, by dividing the annual Orbit of the Earth into 360 Degrees, and measured it accordingly; and not by the Number of Days as *Nature* performs it, and as the ancient Patriarchs did

(p) Introduction, P. 29.—(q) Introduct. P. 28, Let. X. P. 235.

did it.—By this Means, in Order to make the $365\frac{1}{2}$ Rotations of the Earth, in her annual Orbit, to tally and agree with the 360 Degrees of the Equator, they were obliged to contrive and use artificial Numbers.—In my Calculations, I have adopted the ancient Method, as the most easy and certain, and the Method Nature directs.

It appears to me that the Patriarchs and Chaldeans had more Knowledge in Astronomy than is generally attributed to them.—Nay, it appears by what I observed in my last Letter, on the lunar Motions, that they knew very well how to calculate the Return of an Eclipse.—It is allowed by all, that we received the Cycle of 18 Years, for the Calculation of the Return of Eclipses, from them; which is called the *Chaldean Cycle* to this Time.—We also received the lunar Cycle of 19 Years from them; for we are certain, that *Meto*, the *Athenian* Astronomer, made use of it more than 430 Years before Christ. ^(r)—Now, Sir, take away these two Cycles from Astronomers,

(r) Diodorus Siculus, LIB. 12, P. 305.

Astronomers, and they will find themselves at a great Loss, notwithstanding the astonishing Improvements in Arts and Sciences, particularly in Opticks.—For my Part, I do freely acknowledge, (notwithstanding it is so unpopular to do it, in an Age when all Speculations which aggrandize the Dignity of Reason, are so eagerly received,) that I cannot conceive how Adam, just after he was created, could have Knowledge and Understanding sufficient to give *ideal* Names to *all* Animals, &c. unless that Power was given from God,—If God gave him a Power to speak and understand Language; is it unreasonable to suppose that he had Instructions from the same Original, how to calculate, and know when the appointed Seasons were, which God commanded him to keep holy? It belongs *only* to a Tyrant to make Laws which cannot be observed!—Moses taught the Israelites when to *begin* their Days, their Weeks, Months, and Years.—This has much the Appearance of Chronology and Astronomy!

It

It is allowed by *All*, that Astronomers calculate Eclipses, (which are not of long standing) with great Precision; therefore, in Order to confirm what has been observed, I herewith send you Calculations of the succeeding Eclipse, (which will happen on July 25,) by both Methods, viz. the ancient one, by Days, Years, and Lunations, and the present one by Equations and Anomalies, from which you may observe, that the Difference of Time is 8 Minutes and 11 Seconds only: But the Calculations of all Eclipses, by both Methods, will not always agree with the same Exactness; for the Motions of the Moon with the Earth, are so various and complicated and eccentric, that the Angle of her visible Appearance often deceives us, so that equal, true, calculated Time will not agree with that of Observation, occasioned by the Eccentricity of the Moon's Motions, and the Angle of Vision.—This Difference is occasioned much in the same Manner as the variable Angle the Shadow of the Sun makes on a Dial, and the equable and true Division of it by a well regulated Clock.—

Hence, when we trust too much to Appearances and Observations alone, (as Mr. Baudy observes) they often deceive us, as all Astronomers allow.—But, as these Calculations of Time, and the Places of the Sun, Moon, and Earth, by Days, Years, and Lunations, cannot deceive us, they are therefore the most proper and certain to try Chronology by, and to measure the Distance between any two Points of Time.

In my former Letters, I have endeavoured to prove, that the Year of the Creation, according to the Mosaic Chronology, happened at the autumnal Equinox, in the Year answering to 706, of the Julian Period; and that at this very Point or Instant of Time, the Duration of this terraqueous Globe is to be dated from. ^(f) — In that Point, I have made all Calculation to *begin*, and to *end* at some certain Instant of Time, in which we cannot be mistaken or deceived; as at an Equinox or Eclipse.

Now,

(f) Introduction, P. 7, Let. X.

Now, if we know the Number of the Rotations the Equator has made between these two Points, we must be mathematically certain of its Length and Duration. ^(t) And to shew you that it will do so, I have collected the following Data, and prove, by Calculation, that these Data are true.

1st That at the Creation, the Sun was placed in Libra, at Noon, in the first Meridian, on a Thursday, the fourth Day of the Week; when, according to the Mosaic History, Chronology began.

2dly, That the Mosaic Chronology places the Year of the Creation, in the Year 706, according to the Julian Period.

3d, That if the Moon had been in Being, she would have been Full the Day before, at Noon.

4th, That there were four Days, or four Rotations of the Earth, before the Sun was placed in the Haevens.

5th.

(t) Introduction, P. 16, 78 113.

5th, That Moses begins his Chronology on the fourth Day of the Week, at six o' Clock in the Evening, at the going off of the Sun, when the Moon made her Appearance, and they *then jointly* began to perform the Office God designed them for; to *point out Times, Seasons, Days, and Years*;—and that they then enlightened the *whole Earth* from Pole to Pole. ^(u)

This Year, (1786) is the 6499th of the Julian Period; therefore in Order to know the Number of annual Revolutions, since the Creation, I subtract 706 from 6499, which leave 5793; the Number of annual Revolutions since that Time; the last of which will be compleated at this next autumnal Equinox, at the next Full Moon after the Sun enters Libra.—Hence we can measure the Distance between these two Points with a *mathematical Exactness*, superior to a Surveyor measuring a Garden Walk with his Wheel; and that as Nature performs it, by Days, Months, and Years.

(u) Let. X, XIV.

The CALCULATION.

	A. D. 1786	
Multiply by the Number of Minutes a Julian Year is longer than a Solar Trop.	Julian Years	
	5793	
	11	
	<hr/>	
	5793	
	<hr/>	
	5793	
	<hr/>	
Divide by Numb. of Years which compleat the Sun's Cycle	1440	63723 (44 Days
		5760
		<hr/>
		6123
	<hr/>	
	5760	
	<hr/>	
	363	
Hours in a Day	<hr/>	24
	<hr/>	
	1452	
	<hr/>	
	726	
	<hr/>	
	Divide 1440	8712 (6 Hours
		8640
	<hr/>	
	72	
Minutes in an Hour		60 Minutes
	1440	4320 (3
		4320
	<hr/>	
	0000	

Julian

Julian Years.	
A. M. 5793	A. I. P. 6499
1461	Num. of Quadrants in
—	a Quadriennium.
5793	
3475 ⁸	
2317 ²	
5793	
Years in Quadriennium 4)	Days. H. M. (J. Y.
8463573	2115893 6 0 in 5793
1	44 6 3 Retroc.
Sun in Libra	2115848 23 57 1ft M.
add to bring Meridian of Greenwich	10 24
Sun in Libra	2115849 10 21 Lond.
Days from Kalends of Jan. to Oct. 25	298
	2116147 10 21
Julian Biffext. 11 D. deduct for N.S.	2115882
Days from January 1ft inclusive	265 10 21
Sun in Libra, Sept.	22 10 21

According to those Calculations, the Sun will enter Libra this Year, at Greenwich Observatory, Sept. 22d Day, 10th Hour, 21st Minute, and that it was placed in Libra, at the Creation, (or in the 706 of the Julian Period,) at Noon, in the first Meridian, Oct. 25.—But as Moses begins his Chronology at Six o'Clock in the Evening, when the Moon was

was placed nearly in Opposition to the Sun, being a little past its Full, the two Luminaries together enlightened the whole Earth. These six Hours being added, brings it to six in the Evening, Oct. 25th Day, 6th Hour, 0 Minute, P. M.

Another Method.

	D.	H.	M.
Retrocession	44	6	3
Deduct for N. S.	11		
	<hr/>		
	33	6	3
Deduct for Meridian of Greenwich		10	24
	<hr/>		
	32	19	39

	D.	H.	M.	
Oct.	25	6	0	
Sept.	30			added to make a Substraction
	<hr/>			
	55	6	0	
	32	19	39	true Retrocession
	<hr/>			
Sept.	22	10	21	

Moses informs us that his Chronology began at Six o'Clock in the Evening, which was six Hours after the Sun was placed in *Libra*; hence it may be observed, that it was the first Year of the *Quadriennium*; therefore if we add One to the Year of the World,

World, it will always give us the Year of the *Quadriennium*, by dividing that Sum by four, the Remainder the Year sought.

$$\begin{array}{r} \text{Thus } 5793 \\ \quad \quad \quad 1 \\ \hline \text{Divide } 4 \overline{)5794} \begin{array}{l} 1448 \\ 2 \text{ Second} \end{array} \end{array}$$

This History also lets us know, that the Sun was placed in the Heavens, and the Earth began her annual Orbit on a Thursday, the fourth Day of the Week; therefore if we add those four *extra. Days*, to the Number of Rotations the Earth has since made, and divide the whole Number by Seven, it will give us the Number of Weeks since the Creation, and the Remainder will be the Day of the Week.

Thus we find, that from the Sun's entering *Libra*, in the Year 706, A. I. P. to Sept, 22, this Year, when the Sun enters *Libra*, the Earth will have performed 5793 annual Revolutions, and

2115849 Rotations round its Axis

4 extra. Days

Divide 7) 2115853 (302264 Weeks

5 (Friday—According to this Cal-

culatation, we find that Sept. 22, 1786, being the second Year of the Quadriennium, will be on a Friday, the fifth Day of the Week.

Having now proved, by Calculation, that the Sun will enter *Libra* this Year, Sept. 22d Day, 10th Hour, 21st Minute, on a Friday, as it will be found to do from Observation:—I shall now try if the lunar Motions, measured by the Rotations of the Equator, as they are performed by Nature, will also confirm the same.

A. M. 5793 ending at the autumnal Equinox.

Julian Years.

Years in a Cycle, divide by 19) 5793 (304

57

93

76

17

Lunations in a Year

12

204

Intercalary Lunations

5

209

3 D

$$\begin{array}{r}
 304 \\
 235 \text{ Lunations} \\
 \hline
 1520 \\
 912 \\
 608 \\
 \hline
 71440 \\
 \text{Lunations} \quad 209 \text{ Lunar Years} \\
 \hline
 12 \overline{) 71649 (5970} \\
 \underline{60} \\
 116 \\
 108 \\
 \hline
 84 \\
 84 \\
 \hline
 09 \text{ Lunations}
 \end{array}$$

$$\begin{array}{r}
 \text{Lunar Years.} \\
 \text{Years in a Period} \quad 30 \overline{) 5970 (199 \text{ Periods}} \\
 \underline{30} \\
 297 \\
 270 \\
 \hline
 270 \\
 270 \\
 \hline
 000
 \end{array}$$

The Moon's Lunations being a small Fraction less than 29 D. 12 H. 44 M. 1 S. 45 T. cause one Day, (as may be observed) to be thrown off in 138 Periods, or 49,680 Lunations.

Rotations

Rotations or Days		H. M. S.
In 138 Periods are	1467078 (24)	9 00
In 60 Ditto	637860	10 30 00
In 1 Ditto	10631	0 10 30
In 9 Lunations	265 18 36	15
Full Moon, 1st Meridian	2115835	5 25 45
add to bring to Greenwich Observatory		10 24
Full Moon, London	2115835	15 49 45
add Days from Kalends of Jan. to Oct	24	297
	2116132	15 49 45
Julian Biffex. 11 D. deduct for N. S.	2115882	
Days from Jan. 1 inclusive	250	15 49 45
Full Moon, Sept.	7	15 49 45
to bring to New Moon add Half Lunation	14	18 22
New Moon, Sept.	22	10 11 45 This is Sept.
22d D. 10th H. 11th M. 45 S. Morning, according to the Julian Reckoning.		

$$\begin{array}{r}
 \text{Full Moon } 2115835 \\
 \hline
 4 \text{ extra. Days} \\
 \hline
 7) 2115839 \begin{array}{l} (302262 \\ 5 \text{ Friday.} \end{array}
 \end{array}$$

According to the preceding Calculations, the Sun will enter Libra, at the Greenwich Observatory, Friday, Sept. 22d. Day, 10th Hour, 21st Minute, (1786,) being the second Year after the Quadriennium, or after Leap

Leap Year.—The Earth will then have performed, since she entered Libra, A. I. P.

	Rotations or Days	H.	M.
706 —	2115849	10	21

In which Time the Moon will have made 71,649 Revolutions round the Earth, from Sun to Sun, which she has performed in

	Days.	H.	M.
	2115835	15	49
Full Moon	14	18	32 EPACT
Half Lunation	14	18	22
New Moon		10	EPACT

	D.	H.	M.
New Moon, Sept.	22	10	11
Half Lunation	14	18	22

	Full Moon	7	15	49
according the Julian Reck.		8	3	49 Morning.

The aforefaid Motions of the two Luminaries, or more properly, of the Earth and the Moon, as they are performed by Nature, and measured by the equable Rotation of the Equator, (the juſt and true Root of all Meaſure,) prove that the Sun and Moon are now in the ſame Place, in the Heavens, which they were 5793 Years ago.

As

As there will be an Eclipse of the Sun, July 25, this Year, (1786) though invifible to us; I fhall firft calculate this Eclipse, according to the foregoing Method, and then make a Calculation of it from *Ferguson's Tables*, in Order to try whether it will confirm or difprove it.

$$\begin{array}{r}
 \text{A. M.} \\
 19 \overline{) 5793} (304 \\
 \underline{57} \\
 93 \\
 \underline{76} \\
 17 \\
 \underline{12} \\
 204 \\
 \text{Intercatory Lunations} \quad 3 \\
 \underline{\hspace{1.5cm}} \\
 207 \\
 \\
 304 \\
 \underline{235} \\
 1520 \\
 \underline{912} \\
 608 \\
 \underline{\hspace{1.5cm}} \\
 71440 \\
 \underline{207} \\
 12 \overline{) 71647} (5970 \\
 \underline{60} \\
 116 \\
 \underline{108} \\
 84 \\
 \underline{84} \\
 07
 \end{array}$$

398 On ASTRONOMY. Let. XXIII.

30)5970(199

30

297

270

270

270

000

	Rotations or Days.	M.	S.
In 138 Periods are	1467078 (24)	9	00
In 60 Ditto—	637860	10	30 00
In 1 Ditto—	10631	0	10 30
In 7 Lunations	206 17	8	12

2115776 3 57 4
10 24

2115776 14 21 42
10 24

2115776 14 21 42
297

2116073 14 21 42
2115882

Full Moon 191 14 21 42
Half Lunation 14 18 22

206 8 43 42
New Moon, July 25 8 4 24

Days since the Creation.

2115790

4 Extra. Days

7)2115794(302256 Weeks
2 Tuesday

According to these Calculations, this Eclipse
of

of the Sun will happen on a Tuesday, July 25th D. 8th H. 43d M. 42d S. We will now try what is the Time according to *Ferguson's Tables*.

1786	New Moon.	Sun's Anomaly.	Moon's Anomaly.	Sun from Node
	D. H. M. S.	S. D. M. S.	S. D. M. S.	S. D. M. S.
March	18 5 21 30	8 28 6 7	5 11 34 19	2 7 58 12
4 Lunations	118 2 56 12	3 26 25 17	3 13 16 02	4 2 40 56
New Moon, July	14 8 17 42	0 24 31 24	8 24 50 21	6 10 39 8
1 st Equation	1 42 6	8 24 11 33	38 48	
Once Equated	14 6 35 36	4 0 19 51	8 24 11 33	
2 ^d . Equation	9 40 3			
Twice Equated	13 20 55 33	New Moon and Eclipse of the Sun,		
3 ^d . Equation	4 12	D. H. M. S.	according to Ferguson's Tables.	
		July 25 8 51 53	according to Mosaic History	
Thrice Equated	13 20 51 21	July 25 8 43 42	Tuesday—according to Mosaic History	
4 th Equation	32	8 11	Difference.	
Old Style, July	13 20 51 53			
add for N. S.	11			
July	24 20 51 53	New Moon	H. M. S.	after Twelve at Noon, July 24
			20 51 53	
			D. H. M. S.	
			25 8 51 53	
			that is, July 25	

By comparing both these Calculations together, viz. that from the Time and Place of the Sun and Moon at the Creation, according to Moses's History of them, measured by the Rotations of the Equator, as Nature performs them; the other from *Ferguson's Tables*, which being some of the newest, we take it for granted that they are most correct. By comparing both those Calculations together, we find a Difference of 8 Minutes and 11 Seconds only.—Supposing *Ferguson's Tables* to be precisely true, this small Quantity of Difference in Time, can be of no Consequence in 5793 Years or annual Revolutions.

Let it be observed, that there were here two Points given, viz. the autumnal Equinox, 706, of the Julian Period, and the autumnal Equinox, 6499, of the same Period.—Between these two Points the Earth has performed 5793 Revolutions round the Sun, and 2,115,790 Rotations round its Axis. During this Time the Moon has made 71,647 Revolutions round the Earth, and Half of another, when she intersected the Earth's Orbit,

Orbit, and caused an Eclipse of the Sun.— Both these are measured by the equable Rotations of the Equator.

From the Facts and Observations in my former Letters, confirmed by the above Calculations, I shall infer the following Conclusions.

1st. That the equable Rotation of the Equator, round its Axis, is the Root or Standard by which Distance, Duration, and Progression of Time are measured.—By dividing the Equator into twenty-four Parts or Hours, the Duration and Progression of Time is known; by its being divided into 360 Degrees, that of Measure or Distance.—Thus a Revolution of 15 Degrees in Measure, answers exactly to an Hour, or the twenty-fourth Part of the Revolution of the Equator.—In a Minute of Time there will be a Revolution of 15 Minutes of the Equator.—In a Second, a Revolution of 15 Seconds.—Hence, by knowing the Distance or Number of Rotations and Degrees moved forward, or

3 E the

the Length of Time past, the other may be as easily known, by converting Rotations and Degrees into Time, or \P *contra*. Time into Measure.

Thus the Distance between any two Points of Time, (*it being a Strait Line*) may be measured with the greatest Exactness and Precision; for the Number of Rotations the Equator makes, is a strait Line, the exact Length between these two Points;—and it is the Property of a strait Line to measure the Distance between two Points, with a Mathematical Exactness.—By the equable Rotation of the Equator, the annual Orbit is measured. By the same Means, the Moon's Lunations, and her other Motions are measured; and by this Method the foregoing Eclipse, and all the others, have been measured and calculated; which Method will always prove mathematically true, if we know the Number of Rotations, and the Remainder, between any two Points, let their Distance be ever so great, as may be observed in the foregoing Calculations.—The mathematical Exactness
of

of this Measure may be observed, as you may begin at either Point, or at any intervening Eclipse, and they will all come out the same, which no Tables already formed have been able to do.—This Calculation begins at the Point when the Moon came first in Opposition to the Sun, after the Sun entered Libra, 706, of the Julian Period; and ends at the Point of Intersection, when the Moon will be in Conjunction with the Sun, the 25th of this Month.—In this you have not only the Measure between these two Points, by the Earth's Orbit, but you have also the Point where the Moon, in her Orbit round the Earth, intersects the Earth in her annual Revolution round the Sun.—The Moon does not measure her own Orbit or Motions! but by her Intersections of the Earth's Orbit, with the Assistance of the twelve Signs or Stars, Chronology is ascertained, and Times and Seasons pointed out with a mathematical Precision.

2dly, That as Calculations may be made equally true between any one, two, ten, or ten thousand Years, (each beginning and ending

ing when the Sun enters *Libra*, making these Calculations according to 365 Days, 5 Hours, 49 Minutes, being the exact Length of the solar tropical Year;) so it must prove that the Length of the solar Year is 365 Days, 5 Hours, 45 Minutes exactly.—And also that the Length of the Year is precisely the same it was 5793 Years ago.

3dly. That as all or any one of the Moon's Interfection of the Earth, in her annual Orbit, may be calculated with equal Exactness; so I conclude, that the Length of her Luration is properly ascertained; and that in 706, (the Year of the Julian Period, when the Creation happened, according to the Mosaic Chronology,) she was precisely in the Place in the Heavens assigned to her;—that her Orbit is exactly of the same Length it was 5793 Years ago; and that she is now no nearer the Earth than she was then.

4thly. I conclude, (as these Calculations prove) that the Moon was Full, or in exact Opposition to the Sun, Oct. 24, at Noon,
in

in the 706th Year of the Julian Period.—That the Sun entered Libra that Year, Oct. 25, at Noon, one whole Rotation of the Earth, after the Moon was in Opposition to the Sun.—That this happened on a Thursday, the fourth Day of the Week.—That the Moon rose and began to enlighten the Earth at six o'Clock in the Evening, six Hours after the Sun was placed in the Heavens, when the Chronology of Time began. That the Moon was then thirty Hours past her Opposition, but that her Declination was so small, as not to prevent the Sun and Moon to enlighten the **WHOLE** Earth.—That the Moon, by being departed one Quadrant, or six Hours, from the Sun, shews us that 706, A. I. P. must be the Beginning of the second Year of the Quadriennium.

5thly, That these Places of the Sun and Moon, in the Heavens, the Year of the Quadriennium, the Day of the Week, and the Minute of the Day, have not happened again since that Time, viz. in 5793 Years; nor can it happen again for many Thousand Years to come. I

406 *On* ASTRONOMY. Let. XXIII.

I now conclude with assuring you, that I
am, with great Truth,

DEAR SIR,

Your real and affectionate Friend,

F. PENROSE.

STONEHOUSE,

July 12, 1786.



F I N I S.

E R R A T A.

Page	4	Line	4,	for Equatereal, read Equatoreal.
Bottom	8			for LET. XVII. read LET. XXIII.
Bottom	10			for LET. VII. read LET. XI.
	12		14,	for Elipse, read Ellipse.
			18,	dele That
	13		16,	for is, read are.
		Last Line,		for Anomilies, read Anomalies.
	15		4,	dele by.
	16		15,	for Elipse, read Ellipse.
	20		19,	
Note at Bottom				for Horns, read Focus, and is for arc.
	25		2,	for 3420, read 4320.
			10,	for 1783, read 1753.
Bottom	26			for LET. VIII. read LET. X.
	33		3,	for this, read their.
			4,	for their, read this.
	37		17,	for rectify, read rectifies.
	51		11,	for Equinox, read Equinoxes.
	52		24,	for Strauchas, read Strauchius.
	61		13,	for Portes, read Partes.
	74		10,	for Sceptic, read Skeptick.
	78		4,	for 2116214, read 2116219.
			6,	for 30216, read 302317.
			7,	for two Days, read Nothing.
			11,	for fixth, read four.
			12,	for Saturday, read Thursday.
	96			for 11 H. read 1 Hour.
	102		21,	for 5th Hour, read 10th Hour.
	139		1,	for America, read Africa.
	175		18,	for elliptical, read elliptical.
	207		2,	for Placentia, read Placentæ.
	237		17,	for Assumitions, read Assumtions.
	274		9,	for would, read could.
	277		13,	for Quering, read Querying.
	279		7,	after not, insert at.
	316		12,	for Vortix, read Vortex.
	362		6,	after 44 F. read more.
	363		9,	for this, read the.
	280		9,	for Anomilies, read Anomalies.

